TTA TRAINING SCHOOL
LIBRARY.

8

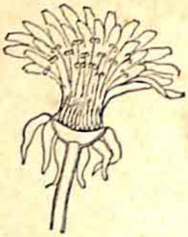


Fig. B

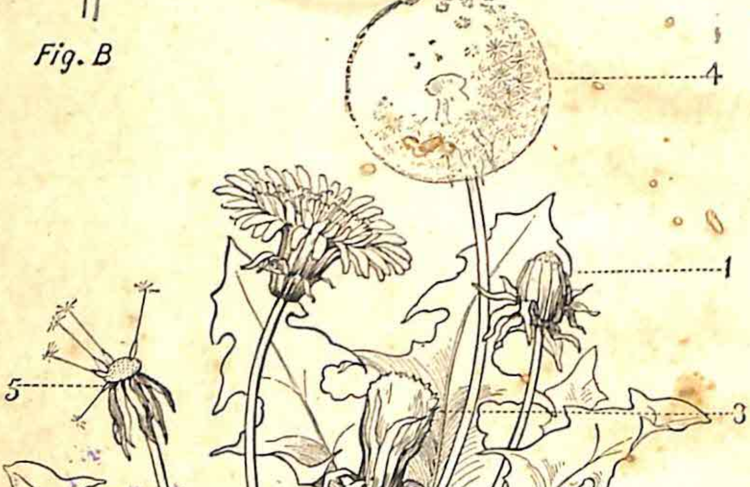


Fig. A

The Dandelion.

NATURE STUDY
AND
THE CHILD

674
~~8279~~
SIE
Ed
674

BY

CHARLES B. SCOTT M.A.

RECENTLY INSTRUCTOR IN NATURE STUDY AT THE STATE
NORMAL SCHOOL OSWEGO N.Y.

> *"And Nature, the old nurse, took*
> *The child upon her knee,*
> *Saying: 'Here is a story-book*
> *Thy Father has written for thee'"*
> *—Longfellow*

~~8279~~

LONDON
D. C. HEATH AND COMPANY
15 York Street Covent Garden

[illegible]
13.8.93
7262

372.3
SCO

Ed
674

ANALYTICAL TABLE OF CONTENTS.

PART I. — AIM AND METHOD IN NATURE STUDY.

CHAPTER I.

The Study of the Dandelion.

PAGE

I. ADVANTAGE OF BEGINNING DISCUSSION OF NATURE STUDY WITH A CONCRETE ILLUSTRATION 1

II. STUDY OF STRUCTURE OF DANDELION AS AN ISOLATED THING
  A. Investigation and description of parts 3
  B. Educational aim and value of such study 8
    1. Broadens knowledge.
    2. Cultivates interest in wayside weed.
    3. Develops power of observation.
    4. Develops power of expression.

III. STUDY OF DANDELION IN ITS RELATIONS TO ITS PHYSICAL ENVIRONMENT 9
  A. Structural or form relations 9
    1. Comparison with other plants 10
      a. Buttercup.
      b. Thistle.
      c. Anemone.
    2. Classification of the four plants 13
    3. Educational aim or value of such study of form relations 14
      a. Broadens knowledge.
      b. May increase and broaden interest in plants.
      c. May further develop power of observation.
      d. May train to express better.
      e. Develops power to compare, discriminate, and group or classify.
    4. Will such study meet the needs of pupils in elementary schools? 15

III. STUDY OF DANDELION (*Continued*) — PAGE
  B. Functional relations, or relations of dependence on and adaptation to physical environment 15
    1. Dependence on environment 15
    2. Adaptation to environment 16
    3. Educational aim and value of such study of life and function 30
      a. Interest is intensified and sympathy developed.
      b. Appreciation of beauty — beauty of function and fitness as well as beauty of form and color — is cultivated.
      c. Prepares for better understanding of unity of nature.
      d. Gives a broader knowledge, a better insight into relations.
IV. STUDY OF HIGHER RELATIONS OF DANDELION 31
  A. Relation to man's physical nature 32
    1. As a medicine and food.
    2. As a weed to combat.
    3. As a plaything for children.
  B. Contributes to man's higher nature 32
    1. Cultivates the appreciation of beauty.
    2. By its life and symbolism appeals to ethical nature.
    3. Is one of the pages of the "manuscript of God."

CHAPTER II.

The Study of the Rabbit.

I. INTRODUCTION 38
  A. Relation to previous chapter 38
  B. Reasons for selecting rabbit 39
  C. Plan followed determined by 40
    1. Aims.
    2. Psychological laws.
    3. Conditions, such as age and capacity of pupils.
  D. Aims and material for study of rabbit 42
  E. Helpful literature 43
  F. Order of lessons 45
  G. Preparatory observational study of 46
      Positions.
      Movements.
      Eating.
      Senses.
      Cleanliness.
      Breathing.
      Burrowing.
      Disposition.

PAGE

II. LESSONS ON RABBIT 49
  - A. LESSON I. *Homes and home life* 49
    - 1. Aim and material needed.
    - 2. Tame rabbit's home. Care of home.
      - Home life.
      - Summary.
    - 3. Tame rabbit's original home.
      - Why domesticated?
      - Houses or burrows.
      - Home life.
      - Enemies.
      - Food and damage they do.
      - Summary.
    - 4. Hare's or "wild rabbit's" home.
      - How distinguished from rabbit.
      - Home.
      - Home life.
    - 5. General Summary and Expressive Work.
      - Oral or written.
      - Reading about rabbits.
    - 6. Adapting the lesson.
  - B LESSON II. *Habits, positions, and movements* 58
    - 1. Positions.
      - When at rest.
      - When asleep.
      - When sitting.
      - When reaching.
      - Summary and Expressive Work.
    - 2. Locomotion.
      - Walking.
      - Hopping.
      - Jumping.
      - Adaptation for locomotion.
      - Summary.
    - 3. Playing, breathing, burrowing.
    - 4. General Summary and Expressive Work.
      - Drawing positions.
      - Writing about habits observed.
  - C. LESSON III. *Habits, feeding, washing, senses* 64
    - 1. Feeding.
      - Child's eating.
      - Rabbit's food.
      - Rabbit's eating.
      - Gnawing.
      - Adaptation.
      - Summary.
    - 2. Drinking.
    - 3. Washing.
    - 4. Hearing, smelling, sight.

II. LESSONS ON RABBIT (*Continued*) — PAGE
  C. LESSON III. (*Continued*) —
    5. General Summary and Expressive Work.
      Writing about habits.
      Reading about habits.
  D. LESSON IV. *Reading related literature* 68
    1. Aim.
    2. Material.
    3. Method.
  E. LESSON V. *Structure of body and limbs* 69
    1. General appearance of rabbit.
    2. Body, trunk, and head.
    3. Tail and limbs.
    4. Skeleton.
    5. General Summary and Expressive Work.
      Drawing.
      Written description.
  F. LESSON VI. *Structure of head, ears, and teeth* . . . 74
    1. Drawing head and appendages.
    2. Head as whole.
    3. Ears, eyes, nose, and "whiskers."
    4. Mouth and teeth.
      Mouth and lips.
      Jaws.
      Teeth.
      Adaptation.
    5. General Summary and Expressive Work.
      Drawing.
      Written description.
  G. LESSON VII. *Comparison and classification. "Gnawers" or Rodents* 79
    1. Aim.
    2. Material.
    3. Method. Essentials in classification.
    4. Comparison of different rabbits.
    5. Comparison of rabbit and hare.
    6. Comparison of rabbit and other rodents.
    7. General Summary and Expressive Work.
  H. LESSON VIII. *Comparison and classification. Vertebrates and Mammals* 83
    1. Comparison of rabbit and cat.
    2. Comparison of rabbit with chicken and fish.
    3. Comparison of rabbit and some invertebrate.
    4. General Summary and Expressive Work.
  I. ADAPTING WORK OUTLINED TO OTHER GRADES . . . 87

CHAPTER III.

What is Nature Study?

PAGE

I. INCREASING ATTENTION GIVEN TO SCIENCE AND NATURE STUDY 89
  A. In university and college.
  B. In secondary schools.
  C. In elementary schools.
II. DEFINITION OF ELEMENTARY SCIENCE 91
  A. Elementary — in aim, material, methods 91
  B. Science, which is 92
    1. Knowledge, defined as
      a. "Clear and certain perception."
      b. "Familiarity gained by actual experience."
    2. Classified — considered in its relations.
  C. Three kinds of elementary science work which do not meet these conditions 93
    1. College science. Science, but not elementary.
    2. Reading "Nature Primers" and "Nature Readers." Elementary, but not science.
    3. Glancing and sipping, not studying carefully. Not science, but may prepare for science.
  D. A definite and graded course of work necessary . . . 96
III. DEFINITION OF NATURE STUDY 96
  A. Term "nature study" better expresses spirit of work . 97
  B. Is *nature* study 97
    1. Personal contact with nature by each pupil.
    2. Nature out-of-doors, as well as in schoolroom.
    3. Life and action as well as form and structure.
  C. Is nature *study* 98
    1. Not mere reading or glancing.
    2. Studied in its relations.
      a. To the whole of which it is part.
      b. To natural environment.
      c. To past and future.
      d. To other individuals, similar and dissimilar.
      e. To causes and effects.
      f. To man.
      g. To the Creator.
      h. To other school-work.
  D. Nature studied 101
    1. By the child.
    2. From the child's standpoint.
    3. By the teacher with the children.
IV. REASONS FOR PLACING SO MUCH EMPHASIS ON DEFINITIONS 101

CHAPTER IV.

The Aim of Nature Study: to Develop the Individual Child.

PAGE

I. WHY INTRODUCE NATURE STUDY IN THE SCHOOL? RATHER ASK, WHY STOP NATURE STUDY WHEN THE CHILD ENTERS SCHOOL? 102

II. IMPORTANCE OF AIM IN METHOD 103
  A. Importance of "why" to teacher.
  B. Importance of "why" to pupil.

III. AIMS OF NATURE STUDY 104
  A. Practically the same as aims of education in general . . 104
  B. Deals with the individual child 105
  C. Oldest recognized aim, the acquisition of knowledge or facts,
    1. Has led to book-work and memorizing.
    2. Knowledge thus gained "shall vanish away."
    3. Value of knowledge gained by personal observation.
    4. Value of "nature knowledge" to geography.
    5. Weakness of knowledge as ultimate aim.
  D. Development of intellectual power a higher aim . . . 107
    1. Shown by history of work in nature study.
    2. Value of nature study as a means of developing power demonstrated.
    3. Value, from this point of view, as a basis for expressive work of school.
  E. Value of knowledge and power gained through nature study as a preparation for practical life 109
  F. Importance of interest and sympathy as an aim . . . 110
    1. Best seen when working with little children.
    2. Mere power gained through nature study may do harm.
  G. Higher aim is cultivation of appreciation of beauty . . 113
    1. Beauty of function and adaptation as well as beauty of form and color.
    2. Is a preparation for the study of literature and art.
    3. Closely related is development of ethical nature.
  H. Highest aim to lead from Nature to Nature's God . . 116
  I. *Résumé* of aims 117
    1. Considering development of individual child.
      a. To awaken interest and cultivate sympathy with nature.
      b. To develop æsthetic, ethical, and spiritual nature, and lead toward God.

PAGE

III. AIMS OF NATURE (*Continued*) —
  1. *Résumé* of Aims (*Continued*) —
    c. To develop intellectual powers, and to form right habits.
    d. To give knowledge of environment.
  2. Considering school-work.
    a. To give foundation for appreciation of literature and art.
    b. To serve as a basis for the expressive work of the school.
    c. To give knowledge, — a basis for geography and other studies.

CHAPTER V.

The Highest Aim: to Adapt the Child to His Environment.

I. DEVELOPMENT OF INDIVIDUAL CHILD NARROW AS AN ULTIMATE AIM 119
II. HIGHEST AIM, ADAPTATION OF CHILD TO HIS ENVIRONMENT, 119
  A. To nature, his physical environment.
  B. To man, his intellectual environment.
  C. To God, his spiritual environment.
III. MEANING OF ADAPTATION TO ENVIRONMENT 123
  A. Has meant making our environment minister to our material needs.
  B. Should include appropriation of beauties of nature, ministering to our higher needs.
  C. Mere appropriation is partial, one-sided adaptation. We owe something to our environment.
  D. Adaptation to environment means appreciation of what we receive from, and recognition and performance of what we owe to our environment, — to nature, man, and God.
IV. HOW NATURE STUDY AIDS IN ADAPTATION OF CHILD TO HIS ENVIRONMENT 125
  A. To his physical environment, — nature 125
    1. Leads to appreciation of beauty of nature, beauty of function, and co-operation, as well as beauty of form and color.
    2. Leads the child to cherish and care for nature.
  B. To his intellectual environment, — man 129
    1. Helps him appreciate what he receives from man.
      a. Puts him in sympathetic attitude.
      b. Nature becomes to child a symbol of man.
      c. Appreciation of nature necessary for enjoyment of much in literature and art.

IV. HOW NATURE STUDY AIDS (*Continued*) — PAGE
  B. To his intellectual environment, — man (*Continued*) —
    2. Helps him to realize what he owes to man, as well as to nature.
  C. To his spiritual environment, — God 129
    1. The child appreciates better the works and gifts and care or providence of God.
    2. Can he do this without better realizing his duty toward God?

CHAPTER VI.

The Limitations of Nature Study. The Two Centres of Education: Nature and Man.

I. NATURE STUDY CANNOT BE MADE BASIS OF A COMPLETE EDUCATION 134
II. NATURE IS BUT ONE CENTRE OF EDUCATION. MAN IS THE OTHER 134
  A. Child must be related to nature, man, God.
  B. Child is related to God through nature and man; hence,
  C. All formal education may be grouped about two centres, — nature and man.
  D. Education incomplete which neglects either nature study or man study.
III. RELATIVE IMPORTANCE OF THESE TWO CENTRES DURING EARLIER AND LATER PERIODS OF ELEMENTARY EDUCATION 138
  A. Child world is a world of sense; hence nature study most important centre in earlier education.
  B. Intellectual environment, — man study should be prominent in later education.
  C. Application to school-work.
    1. To nature study, history, and literature.
    2. To work based on these, reading, writing, drawing, geography, arithmetic.
IV. LIMITATIONS OF NATURE STUDY 141
  A. It provides for adequate study of but part of child's environment, — nature.
  B. It does not give child the benefit of a knowledge of the experiences of the past.
  C. It does not necessarily provide for adequate formal work in expressive studies.

CHAPTERS VII AND VIII.

Principles Determining Method in Nature Study.

PAGE

- I. METHOD INVOLVES CONSIDERATION OF THREE TOPICS . . . 144
  - A. The study of material, including
    - 1. Presentation of matter to pupils.
    - 2. Expression by pupils.
    - 3. Relation to other school-work.
  - B. The selection of material for study.
  - C. The arrangement of material and formulation of a course of study.
- II. AIMS IN NATURE STUDY, DETERMINING METHOD 145
  - A. *Résumé* of aims already formulated.
  - B. Ultimate and mediate aims.
  - C. Importance of understanding aim.
  - D. Care in stating aim.
- III. PRINCIPLES OR LAWS OF CHILD MIND MOST IMPORTANT IN METHOD 148
  - A. Sense perception 150
    - 1. Importance.
    - 2. Neglect of, in education of past.
  - B. Apperception 152
    - 1. Definition.
    - 2. Comparison with physiological assimilation.
    - 3. Basis for other laws enumerated.
  - C. Interest 154
    - 1. Relation to previous steps.
    - 2. Comparison with appetite.
    - 3. Value of sympathetic interest.
    - 4. Direct and indirect interest.
    - 5. Means of maintaining interest.
      - *a*. Apperceptive work.
      - *b*. Novelty.
      - *c*. Participation, or self-activity.
      - *d*. Personification, or imaginative work.
  - D. Imagination 158
    - 1. Definition and kinds.
      - *a*. Reproductive imagination or memory.
      - *b*. Constructive imagination.
    - 2. Memory.
      - *a*. Importance in education.
      - *b*. Means of training memory.
        - 1′. Laying foundation in sense-perception.
        - 2′. Importance of association in establishing relations.
        - 3′. Necessity of repetition or drill.

III. PRINCIPLES OR LAWS (*Continued*) — PAGE
  D. Imagination (*Continued*) —
    3. Constructive imagination.
      a. Importance in education.
      b. Means of cultivating imagination.
        1′. Basing on sense-perception and apperception.
        2′. Giving imagination exercise.
        3′. Value of literature.

(*Chapter VIII.*)

  E. Sequence 167
    1. Definition and relation to apperception.
    2. Precautions to insure sequence.
      a. Laying good foundations.
      b. Going step by step, not leaping.
      c. Keeping to the line of thought, and avoiding digressions.
      d. "Guarding the switches."
    3. Use of the development or Socratic method.
    4. Value of sequence for developing reasoning-powers.
  F. Unity 177
    1. Definition and relation to preceding principles.
    2. Unity is ultimate psychological aim corresponding to the ultimate ethical aim, adaptation to environment.
    3. Unity is psychological basis or reason for the greater educational value of the study of life, the best exemplification of physical unity.
    4. Unity is brought out by questions "why" and "how," rather than by question "what."
    5. Influence of unity on method.
      a. How impress on child unity in his physical environment?
      b. How impress on child unity of physical and intellectual environment?
      c. How impress unity of all environment?
      d. How bring child into unity with environment?
  G. Expression[1] 190
    1. Definition and relation to preceding principles.
    2. Function or objects.
      a. To clarify the child's ideas.
      b. To convey his ideas to other minds.
      c. To enable him to get ideas from other minds.

---

[1] See also Chapter XI. on "Nature Study and the Expressive Work of the School."

CHAPTERS IX AND X.

The Order and Method of Studying Material. Application of Principles.

PAGE
I. ORDER OF STUDY 192
  A. How determined.
    1. By aim.
    2. By necessity of basing work on sense perception.
  B. Order followed.
    1. Name.
    2. Relations to natural environment.
    3. Habits and function (and life history?).
    4. Adaptation to environment and to function, or structure (and life history ?).
    5. Comparison and classification, or association and generalization.
    6. Application.
II. STUDY OF NAME 193
III. STUDY OF RELATIONS TO NATURAL ENVIRONMENT 194
  A. Importance from standpoint of unity.
  B. Field lessons.
    1. Purpose and value.
    2. Conduct: determined by aim and conditions.
      a. Lack of restraint among children.
      b. Help from literature.
      c. Studying what cannot be studied indoors.
      d. Order.
      e. Importance of definite aim, plan, and report.
IV. STUDY OF LIFE, HABITS, AND FUNCTION 202
  A. Relation to previous step in study of animals, plants, minerals, physics.
  B. Relation to study of life history.
  C. Importance and educational value.
    1. Interests and appeals to children.
    2. Leads children to think.
    3. Prepares for understanding of structure.
    4. Correlates best with literature.
    5. Gives best opportunity for individuality.
  D. Suggestions for study of life, habits, and function.

(*Chapter X.*)

V. STUDY OF STRUCTURE, OR PROPERTIES, OR OF ADAPTATION TO ENVIRONMENT AND TO HABITS AND FUNCTION . . 208
  A. Relation to previous step and to next step.
  B. Adapting to grade of children.

V. STUDY OF STRUCTURE (*Continued*) — PAGE
- C. Studying details of structure or unimportant properties.
  - 1. Study those which throw light on function or use.
  - 2. Study those which aid in classification.
- D. Dissecting animals and plants.
- E. Use of microscope.
- F. Order in studying and describing structure.
  - 1. Similar to order followed in making a drawing.
  - 2. Rules for determining order.
    - *a.* Study whole, then parts.
    - *b.* In studying parts, first relate to whole.
    - *c.* Work from base upward, from outside inward.
    - *d.* Emphasize parts which children can understand, and in which they are interested.
- G. Use of drawing in studying structure.
  - 1. Requires careful, exact observation.
  - 2. Value of drawing before description.
  - 3. Importance of analyzing object before drawing.
- H. Use of technical terms.
  - 1. Value: express ideas exactly and concisely.
  - 2. Useful to children only when necessary to express their ideas.
  - 3. Necessity of making meaning clear.
- I. Relation to study of life history.

VI. COMPARISON AND CLASSIFICATION, OR ASSOCIATION AND GENERALIZATION 224
- A. Relation to previous steps.
- B. Purposes or objects.
  - 1. To note resemblances and differences.
  - 2. To distinguish essentials from non-essentials.
  - 3. To recognize or abstract plan or principle.
  - 4. To apply to other phenomena and arrange knowledge in groups, each represented by a type.
- C. Relation to grade of children.
- D. Suggestions for work in comparison and generalization.
  - 1. Preparation in study of structure.
  - 2. Selecting for study material which is typical.
  - 3. Dwelling on resemblances rather than differences.
  - 4. Emphasizing essentials and overlooking unimportant details.
  - 5. Avoiding generalizations from very few particulars.

VII. APPLICATION 230

VIII. MODIFYING AND ADAPTING ABOVE ORDER OF STUDY . . . 232

IX. APPLICATION TO STUDY OF MINERALS AND PHYSICS . . . 234

CHAPTER XI.

Nature Study and the Expressive Work of the School.

PAGE

I. IMPORTANCE OF DEMONSTRATING VALUE OF NATURE STUDY IN OTHER SCHOOL-WORK 236

II. VALUE OF NATURE STUDY IN OTHER SCHOOL-WORK . . . 237
  - **A.** Definition of content studies and of formal or instrumental or expressive studies.
  - **B.** Importance of making content studies basis for expressive work.
  - **C.** Special value of nature study, [illegible] content study, in work with young children.
  - **D.** Advantages of closely correlating nature study and expressive studies.

III. OBJECTS OF EXPRESSION OR EXPRESSIVE WORK 241
  - **A.** To clarify our own ideas.
  - **B.** To convey our ideas to others.
  - **C.** To prepare us to gain ideas from others.

IV. FORMS OF EXPRESSION AND THEIR EDUCATIONAL VALUE IN THE ELEMENTARY SCHOOL 241
  - **A.** Motion or gesture 241
    - **1.** Function — to express action and direction.
    - **2.** Importance, with young children.
  - **B.** Music 242
    - **1.** Use depends on realization of aim.
    - **2.** Value for expressing and appealing to emotions.
  - **C.** Sewing 244
    - **1.** Function — to express and fix form and color.
    - **2.** Limitations.
  - **D.** Moulding or modelling 244
    - **1.** Special value for expressing form.
    - **2.** Limitations.
  - **E.** Drawing 246
    - **1.** Great value in nature study for expressing form ideas.
    - **2.** Advantages as an "eye language."
      - *a.* Is most natural means of expression.
      - *b.* Is clearest means of expression.
      - *c.* Is most exact means of expression.
      - *d.* Is most concise means of expression.
    - **3** Drawing as a language of greater educational value than as a means of artistic training.

V. FORMS OF EXPRESSION (*Continued*) — PAGE
F. Painting 250
1. Function — to express color.
2. Difficulties.
G. Language 250
1. Importance — the most general means of expression.
2. Difficulties in expressing by means of language.
3. Value — to express life, action, function, æsthetic, ethical, and spiritual ideas.
4. Varieties of language expression and their use.
a. Description — impersonal.
b. Narration — personal.
c. Personification — exercises imagination.
H. *Résumé* of relative use and value of above forms of expression 254
V. ESSENTIALS IN ALL EXPRESSION AND SUGGESTION FOR EXPRESSIVE WORK 255
A. Individuality 256
B. Truthfulness 258
C. Clearness 261
D. Order 262
VI. LIMITATIONS OF NATURE STUDY AS A BASIS FOR EXPRESSIVE WORK OF SCHOOL 263

CHAPTER XII.

Relation of Nature Study to Reading and Literature.

I. THE PRIMARY READING-LESSON BASED ON NATURE STUDY, 265
A. Purpose 265
1. To help fix important ideas.
2. To give pupils practice in,
a. Expressing ideas in language.
b. Gaining ideas through language.
3. To serve as models for individual expressive work.
B. Essentials in primary reading-lessons 267
1. Should contain best ideas in best form.
2. Should be in accord with principles already discussed.
a. Should be based on perception and apperception.
b. Should exercise imagination.
c. Should have sequence and unity.
3. Value of narration and personification.
4. Should be truthful, clear, and orderly.

PAGE

I. THE PRIMARY READING-LESSON (*Continued*) —

- C. Suggestions for primary reading-lessons 268
  - 1. Making them models for individual written work.
  - 2. Keeping statements in order or sequence.
  - 3. Supplementing ideas gained from children with higher and broader ideas.
  - 4. Value of literary gems.

II. NECESSITY OF BASING PART OF READING WORK ON MAN STUDY 273

III. SUPPLEMENTARY READING BASED ON NATURE STUDY . . . 273

- A. Two classes of supplementary reading 274
  - 1. Reading for information.
  - 2. Reading for inspiration — literature.
- B. Reading for information 274
  - 1. Purpose.
  - 2. Characteristics.
  - 3. Relation to nature study.
- C. Reading for inspiration — literature 275
  - 1. Greater educational value.
  - 2. Relation to nature study.
  - 3. Necessity of reading real literature.
    - *a.* Avoiding mere rhyme or "jingle."
    - *b.* How select the best.
  - 4. Value to children of reading what is above them rather than below them.
  - 5. Manner of reading literature.
    - *a.* Determined by aim — inspiration.
    - *b.* Reading so as to give the thought.
    - *c.* Reading again and again.
    - *d.* Avoiding excessive analysis or dissection.
  - 6. Value of literature to nature study.

CHAPTER XIII.

Relation of Nature Study to Geography and Arithmetic.

RELATION TO GEOGRAPHY.

I. DEFINITION OF GEOGRAPHY 281

- A. Geography is "earth study" 281
  - 1. Must be real "earth study," based on sense-perception.
  - 2. Must begin with what is nearest.
  - 3. Physical geography must precede political geography.
  - 4. Geography in German schools.

I. DEFINITION OF GEOGRAPHY (*Continued*) — PAGE
- B. Geography is study of the life of the earth 283
  - 1. Not mere study of form and structure, the earth as it is.
  - 2. Must include study of action and processes, the development of the earth.

II. CLOSE RELATION BETWEEN NATURE STUDY AND GEOGRAPHY, 283

III. HOW CAN NATURE STUDY BE MADE MOST HELPFUL IN GEOGRAPHY? 284
- A. Practical importance of question 285
- B. How can nature study in lower grades be made most helpful as a preparation for geography? 285
  - 1. Physical environment of child includes:
    - *a.* The earth as a planet.
    - *b.* The earth itself and its three envelopes, — land, water, air.
    - *c.* The inhabitants of the earth, — plants, animals, man.
  - 2. Study of earth as a planet.
    - *a.* Conception too difficult for young children.
    - *b.* Preparatory observational work.
  - 3. Study of earth itself, including earth forces, earth materials, earth forms.
    - *a.* Study of earth forces, beginning with water, air, and heat.
    - *b.* Study of earth materials, — water, air, minerals, rocks, soil.
    - . Study of earth forms, or forms of land and water.
  - 4. Study of inhabitants of earth, — plants, animals, and man.
  - 5. Necessity for man study, as well as nature study, as a basis for geography.
- C. How can work in nature study in upper grades be made most helpful in geography? 290
  - 1. Systematic study of relations between earth and other heavenly bodies.
  - 2. Intensive study of minerals and rocks.
    - *a.* Those most abundant as earth materials.
    - *b.* Those of greatest economic importance.
  - 3. Study of aërial envelope or weather study.
  - 4. Emphasis on practical or economic aspects of plant and animal study and on physics.

IV. NATURE STUDY MUST BE MORE THAN AN ADJUNCT TO GEOGRAPHY. WE MUST KEEP IN MIND HIGHER AIMS AND VALUE OF NATURE STUDY 292

RELATION TO ARITHMETIC.

PAGE

I. FIELD OF ARITHMETIC. DEALS WITH NUMBER AND SIZE RELATIONS (THE "HOW-MUCHNESS") OF THINGS . . . 292
II. RELATION OF ARITHMETIC TO NATURE STUDY 293
  A. In nature study, as pursued in elementary schools, number and size relations of minor importance as compared with form and function 293
  B. Danger of forcing too close correlation between nature study and arithmetic 294
    1. Danger to nature study.
      a. Emphasizes details (size and number) in nature study which are accidental or of minor importance.
      b. Sacrifices higher work, or loses sight of higher aims.
    2. Danger to arithmetic.
      a. May not provide for adequate drill.
  C. Value of nature study in co-operation with arithmetic . 295
    1. Furnishes material for concrete work in arithmetic.
    2. Trains in exactness in observation, expression, and thought.

CHAPTER XIV.

Selection and Sequence of Material.

I. SELECTION OF MATERIAL DETERMINED BY
  A. The aim.
  B. The nature and development of the children.
  C. The prevailing conditions.
II. INFLUENCE OF DIFFERENT AIMS ON SELECTION OF MATERIAL 297
  A. Of interest as an aim. Importance of considering . . . 297
    1. Interest of teacher.
    2. Interest of children.
    3. Interest of parents.
  B. Of cultivation of higher nature as an aim 300
    1. Greater value of material showing life and action.
    2. Application to plants, animals, minerals, physics.
  C. Of development of intellectual power as an aim . . . 301
    1. Power must be developed by individual activity.
    2. Importance of material which will admit of individual work.

II. INFLUENCE OF DIFFERENT AIMS (*Continued*)— PAGE

- C. Of development of intellectual power as an aim.
  - 3. Relative value for individual work of plants, animals, minerals, physics.
  - 4. Development of power mainly dependent on method of study.
- D. Of acquisition of knowledge as an aim 303
  - 1. Knowledge of what material most helpful in other school-work.
    - *a*. Life sciences best prepare for literature.
    - *b*. Plants and animals best for free individual expressive work.
    - *c*. Physics and chemistry most exact and best correlate with arithmetic.
    - *d*. Knowledge most helpful in geography.
      - 1′. Of "earth forces,"—air, water, heat.
      - 2′. Of "earth-materials,"—common minerals, rocks, and soil.
      - 3′. Of "earth inhabitants," particularly plants and animals of economic importance.
  - 2. Knowledge of what material most helpful in subsequent science work.
    - *a*. Importance of material which is typical and of phenomena which best illustrate principles.
    - *b*. Importance of sequence in study of material.
    - *c*. Importance of beginning and ending with wholes and of relating parts to wholes.
  - 3. Knowledge of what material of greatest practical value in life?
    - *a*. Utilitarian considerations have most weight in later school-years.
    - *b*. Practical value of physics and chemistry and of economic aspects of plant, animal, and mineral study.

III. INFLUENCE OF PSYCHOLOGICAL PRINCIPLES ON SELECTION AND SEQUENCE OF MATERIAL 311

- A. Dependence of children on sense-perception and apperception 312
  - 1. Concrete material — plants, animals, minerals — better for young children.
  - 2. Forces — physics — reserved for older pupils.
  - 3. Greater value of most common things.
- B. Lack of permanence in interests and acquisitions of young children 314
  - 1. Need of variety with young children.
  - 2. Intensive study with older pupils.
  - 3. Necessity for studying same topics again and again.

III. INFLUENCE OF PSYCHOLOGICAL PRINCIPLES (*Continued*) — PAGE
- C. Arranging work in two cycles 316
  - 1. First cycle — first four years — work extensive.
  - 2. Second cycle — going over same ground intensively.

IV. INFLUENCE OF OTHER CONDITIONS ON SELECTION AND SEQUENCE OF MATERIAL 316
- A. Of season and climate 316
  - 1. Study life sciences when nature is awake.
    - *a.* Plants mainly in the spring.
    - *b.* Animals mainly in fall.
  - 2. Study physical sciences during winter.
  - 3. Some animal work (birds) in spring, and some plant work (seeds and fruits) in fall.
- B. Of teacher 318
  - 1. Of her interests.
  - 2. Of her preparation for nature study.
    - *a.* Teachers usually best prepared for plant study and elementary physics.
    - *b.* Lack of preparation limits teacher to one or two lines of nature work at one time.
- C. Of local school conditions 321
  - 1. Of time devoted to nature study. When time is very limited study:
    - *a.* Plants and elementary physics in lower grades.
    - *b.* Plants, animals, minerals, physics, in upper grades.
  - 2. Of amount and character of previous work in nature study.
    - *a.* When beginning, best work done by younger pupils.
    - *b.* In beginning, better to introduce into lower grades alone than into upper grades alone.
    - *c.* When beginning, begin in all grades with foundation work.
  - 3. Of tendency of pupils to drop out of school in intermediate grades.
    - *a.* Reason for arranging course in two cycles.
  - 4. Of equipment for work.
    - *a.* Only home-made equipment essential.
    - *b.* Complex costly apparatus detrimental.
    - *c.* Science laboratory may be a detriment.
- D. Of location of school 323
  - 1. That best which is most common in vicinity of school.
  - 2. That suggested in course of study which is most widely distributed.
  - 3. Relative emphasis on topics influenced by local conditions and interests.
  - 4. Material for study in cities.

CHAPTER XV.

A Graded Course of Nature Study.

PAGE
I. INTRODUCTORY 329
    A. History of the course 329
        1. Gradually evolved from experience 329
        2. Most of the work indicated done again and again . 330
    B. Time required for the work 330
    C. Abridging and adapting the course 330
II. THE COURSE OF STUDY 331
    A. First cycle — years one to four 331
    B. Second cycle — years five to nine 336

PART II. — DETAILED OUTLINES.

Fall Plant Study.

SEPTEMBER.

The Common or Round Leaved Mallow 344
The Buttercup 361

OCTOBER.

The Dissemination of Seeds 370
The Milkweed 371
The Dandelion 381
    Other plumed seeds 385
    The Maple Seed and other winged seeds 387
The Chestnut 393
Falling and Coloring of Leaves 395

NOVEMBER.

The Study of Fruits 400
The Apple 402

DECEMBER.

The Pine 410
Other Evergreens 425

Fall and Winter Animal Study.

SEPTEMBER.

Caterpillars and Butterflies 427

OCTOBER.

Grasshopper or Cricket 439

JANUARY.

The Cat 449

Winter Earth Study.

PAGE
WATER—ITS FORMS AND WORK 462
Evaporation 465
Condensation 476
FORMS OF WATER 478
Frost 486
Ice 491
Snow 494
The Work of Water in Soilmaking 513
The Work of Streams 518

Spring Nature Study.

Aims and Opportunities 520
Spring Notes 526

MARCH.

Tree Study 531
Bud Study 547
The Horse Chestnut Bud 551
The Lilac Bud 555
The Beech Bud 560
The Elder Bud 561
Willow, Poplar, and Maple Buds 562

APRIL.

Seeds and their Dissemination 566
Planting the Seeds 569
The Germination of the Bean 573
" " " " Pea 579
" " " " Morning Glory 583

MAY.

The Plant at Work 593
The Germination of the Bean, continued 596
" " " " Morning Glory, continued 602
The Horse Chestnut Bud 609

JUNE.

The Flowers and Their Work 613

NATURE STUDY.

CHAPTER I.

THE STUDY OF THE DANDELION.

An Introduction to Nature Study.

> "Flower in the crannied wall,
> I pluck you out of the crannies;
> Hold you here, root and all, in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is."
>
> TENNYSON.

It seems wise, in beginning to consider nature study by and with the children, to illustrate by a concrete example much which will be discussed and elaborated in detail in succeeding chapters. In this preliminary study of some part or phase of nature, we can be helped to realize what is meant by nature study by and with children, as distinguished from natural science as commonly pursued by older pupils, and can see illustrated something of the method, and gain some idea of the aim and principles on which the method is based. After such preliminary concrete work we shall be better prepared for the discussion in succeeding chapters of definitions, aims, and principles, and of the application of these to method.

The work as outlined in this preliminary chapter is not to be considered as a model or plan of work to be followed by the teacher in studying with her pupils the dandelion or any other plant. The chapter is intended to show the different points of view from which the dandelion may be approached, and the different ways in which it may be studied, and to compare the relative educational value of these different methods of study.

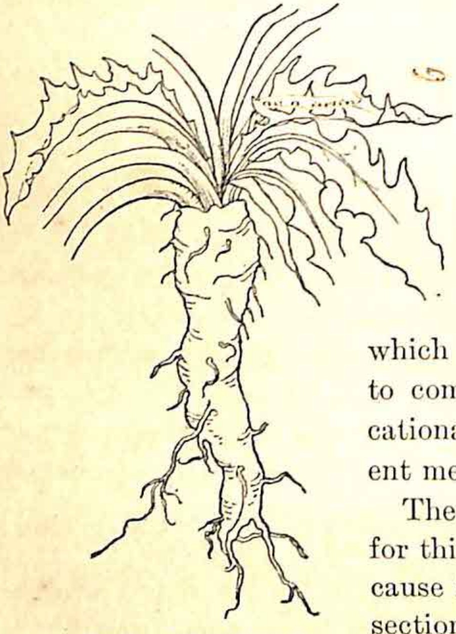


Fig. 1. Root of Dandelion.

The dandelion is selected for this preliminary study because it is so familiar in many sections of the country, and can be obtained and studied during several months, and because its many interesting habits and adaptations of structure to work or function make it particularly good for illustrating method in nature study.

While an effort is made to illustrate by drawings all points of structure which are considered, drawings cannot take the place of the dandelion itself. This chapter will mean much more, be better understood and better appreciated, and will better prepare for later chapters, if the reader will take the book out-of-doors, and there, with the dandelions all about him, investigate for himself. There he will not only best understand the facts, but will discover the spirit in which nature should be approached.

We will dig up our dandelion, wash off the dirt, and describe it, as many of us have done in our work in botany.

We find that the root (see Fig. 1) is thick, long, and somewhat tapering (what the botanist calls a *conical tap-root*), and that it has some thread-like branches. When we cut it across (make a *cross-section*) we see that a milky liquid exudes, and discover that it has a central cylindrical axis, rather strong or tough, surrounded by a lighter-colored, less dense ring. (It is *exogenous* in structure.) We describe the dandelion root as *a tap-root, cylindrical or conical, exogenous, containing a milky liquid.*

As the plant has no distinct stem, it may be called *stemless*. It really has a very short stem, from which the leaves grow. What is commonly called the stem is the flower stem, not the plant stem.

The leaves seem to grow from the root (hence called *radical*), no two successive leaves (see frontispiece, Fig. A) growing from the same level (*alternate*). They are long and narrow (see Fig. 2), with large irregular lobes which are separated almost to the middle line (*pinnatifid*) and often inclined downward toward the base of the leaf (*runcinate*); and with a central vein running from base to point, or apex, sending out branches into the divisions on either side (*feather veined* or *pinnately veined*). The leaves are smooth on both upper and lower surfaces (*glabrous*). We can, then, describe the dandelion leaves concisely as *radical, alternate, runcinate, pinnately veined, glabrous.*

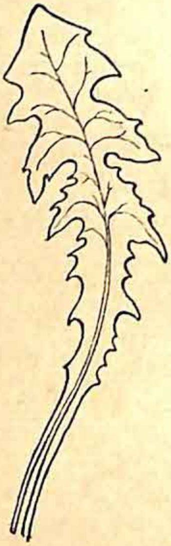


Fig. 2.
Leaf of Dandelion.

The blossom (see frontispiece) has a leafless (*naked*) stem (called a *scape*), hollow, cylindrical, containing a milky liquid. It is enclosed in rows or concentric circles (usually three in number) of green, somewhat leaflike parts (called *bracts*, forming together the *involucre*), the divisions, or parts, overlapping like shingles on a roof (*imbricated*). The parts of the inner and upper row are long and narrow (*linear*), and nearly vertical (*erect*), while the parts of the other rows are somewhat shorter, and are bent outward and downward (*reflexed*).

The yellow part of the dandelion blossom, surrounded by the involucre, is found, when examined carefully, to be composed of a large number (one hundred to three hundred) of similar parts. (See frontispiece, Fig. B.)

Each of these is fastened directly, that is, without any stem (hence called *sessile*), in the enlarged upper end (*receptacle*) of the flower-stem, or scape. Each (see Fig. 3), when carefully separated from the receptacle, is found to have at its base a small rounded body which, when examined with a magnifying-glass, is seen to consist of a minute sack (the *ovary*), enclosing a single seed (the seed and its enclosing sack forming when ripe an *akene*), with a very short stem above the ovary (called the *beak*). Extending upward and outward from the upper end of the beak are a great number of fine, soft hairs (the cluster of hairs being known as the *pappus*), in the position of and representing the outer part (the *calyx*) of ordinary flowers, such as the buttercup. (See Fig. 5.) Surrounded by these hairs, and attached, like them, to the upper end of the beak above the ovary (hence called *epigynous*, meaning upon or above the ovary), is the larger, more prominent division, the *corolla*. (Compare with same part in the buttercup, Fig. 5). This is much longer than the pappus, yellow, united at base into a short tube, and split open and spread out flat above into a long strap-shaped (*ligulate*) corolla, with usually five minute teeth at the upper end, indicating in a rudimentary way the division of the corolla into *petals*. (See Fig. 5.) An upward thread-like extension of the beak (called

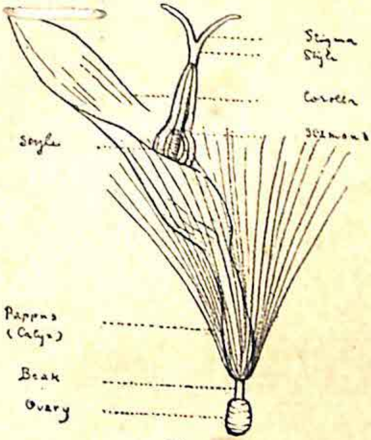


Fig. 3.
Flower of Dandelion Enlarged.
Single Flower.

the *style*) passes through the tubular base of the corolla, separating above into two parts (*two-cleft*), the inner surface of the upper ends of these divisions being somewhat rough or spongy when the flower is fully developed. These roughish surfaces form the *stigma*. The ovary, style, and stigma taken together constitute the *pistil* of the little flower. Very careful examination with the magnifying-glass shows five minute thread-like parts (the *stamens*), forming a tube about the style. The slender, thread-like base (*filament*) of each stamen is fastened in the tubular base of the corolla. Hence the stamens are said to be *epipetalous*, meaning on or upon the petals. The enlarged upper parts (*anthers*) of the stamens are united to form a tube about the style. (Stamens thus united are *syngenesious*.) On the anthers when ripe is often a yellow powder (the *pollen*). Each of these similar yellow parts, surrounded by the involucre, and growing from pits in the receptacle, has all the parts of a complete flower, — calyx, corolla, stamens, and pistil. (Compare with the buttercup.) Hence each may be called a little flower, or a *floret*.

Flowers so arranged in clusters, growing directly from the receptacle, are said to be in a *head*. Because the dandelion is composed of many of these flowers or flower-like divisions, or florets, arranged in a head, surrounded by an involucre, it is called a *composite* flower.

We can describe the dandelion blossom, using the terms above defined, as: *Growing on a naked, hollow* *scape, composite, with an involucre of (usually) three rows of imbricated linear green bracts, the inner longer row erect, the outer rows reflexed. Individual flowers arranged in a close head. Parts epigynous, borne on a short beak. Calyx a pappus of many fine white hairs. Corolla yellow, strap-shaped, with five teeth. Stamens five, epipetalous, syngenesious. Pistil one, with one-celled, one-seeded ovary (forming in fruit an akene), with a long style, two-cleft.*

In the dandelion fruit, or matured flower, the stems usually grow much longer, and the hundreds of little seeds become loosened, ready to be detached from the little pits or pores in the enlarged end of the stem. Each seed (see Frontispiece, Fig. A, 5) is somewhat egg-shaped, but flattened, has about its upper half a number of minute teeth pointing upward, and bears at its upper end a long hairy stem which separates into many spreading hairs. When spread out the stem and its parts somewhat resemble the handle and ribs of an open umbrella, with the seed fastened at the lower end of the handle. The hairy balls, or fruit, of the dandelion (see frontispiece, Fig. A, 4) may be described as *spherical, open, hairy clusters.*

We have studied and described the dandelion as a form or structure, and no more. Our description thus far might apply as well to a dandelion fashioned out of clay or glass as to the weeds which struggle in our yards and thrive by our roadsides, and smile back at the sun. We have not said a word, or apparently had a thought, about its life, — that which distinguishes the real dandelion from its clay or glass counterfeit. We have considered the dandelion as something isolated from all the world, having no relations to anything else.

We have studied and described the plant somewhat carefully, with a free use of technical terms, but it would be most unwise, in work with children, to begin with such dissection and dry technical description. This study of structure is merely a basis for further work in this and subsequent chapters, and is not intended to serve as a model for teachers to follow in their work with children.

Incidentally, hitherto, we have seen the value of technical or scientific terms in describing structure concisely and exactly, and have learned, as we referred to the pictures to understand the descriptions in the text, that pictures illustrate flower structure much better than words can describe it.

But what can we gain from such a study? What is the educational aim or value of such study of mere form and structure?

First. We may widen our range of thought, and add to our previous store of information concerning the form of the dandelion, and the relation of its parts.

Second. We may gain an interest in the dandelion. The common, and perhaps despised, wayside weed becomes a complex and wonderful structure. It would become still more marvellous if we could study with the microscope its minute details; but this does not seem wise, nor even possible, for those for whom this book is planned.

Third. We may learn, if we actually study the dandelion itself with care, and not merely read or hear about it, to develop our powers of observation.

Fourth. If we endeavor to speak about what we have observed, and are not content with repeating what others have told, we may learn, and particularly if we use technical terms, to express more clearly, exactly, and concisely what we have to say.

Theoretically, we can study the dandelion as an isolated thing. Practically, the youngest child in the kindergarten cannot avoid comparing the dandelion with other things he has seen; in fact, the same habit of comparing everything we see goes on continually throughout life. Assuming, therefore, that we have learned to recognize the dandelion as a plant, as distinguished from animals and minerals, and to associate it with other plants having flowers, we may begin to make suggestive comparisons.

Let us first select the buttercup for comparison with the dandelion. The two are alike in having roots, leaves, and flowers, but are unlike in the form and arrangement of these parts. Instead of one strong tap-root, such as the dandelion has (see Fig. 1), the buttercup has many rather slender roots, starting from the lower end of the stem (see Fig. 4). Its roots are *multiple* and *fibrous*. It has a distinct stem, to which many of the leaves are attached. This stem is cylindrical, and a careful study of a cross-section shows its structure to be, like that of the dandelion, exogenous. The leaves (see Fig. 5) are alternate, have distinct leaf-stalks (*petioles*), and have several veins branching out from the top of the leaf-stalk, somewhat as the fingers, when spread out fan-like, are attached to the main part, or

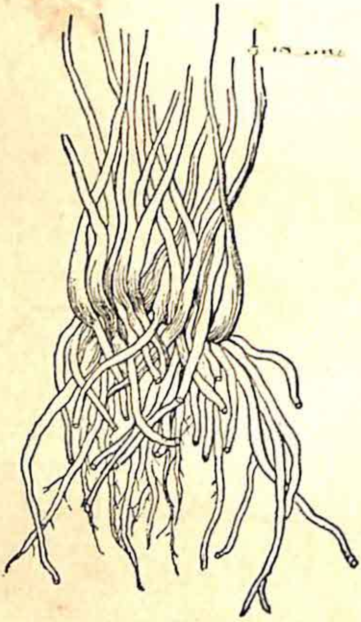


Fig. 4.
Roots of Buttercup.

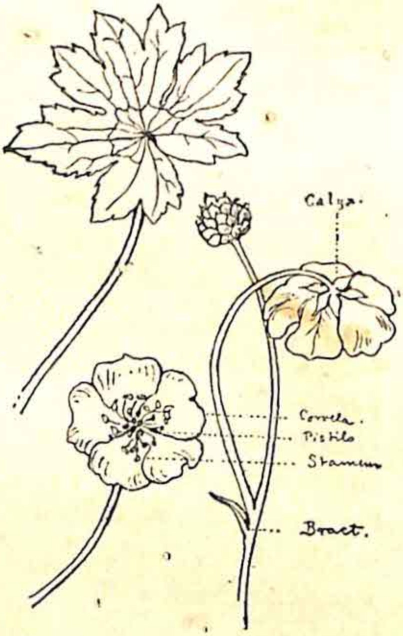


Fig. 5.
Buttercup Leaf, Flower, and Fruit.

palm, of the hand. Hence it is said to be *palmately veined.* The shape of the leaves, however, is entirely unlike that of the dandelion leaves.

When we examine the flower of the buttercup (see Figs. 5 and 6), the most important part of the plant in classification, we find that each flower is separate, with a distinct flower stem, instead of having, as in the dandelion, many minute flowers without stems crowded in a close cluster, or head. Each complete flower has an outer green calyx, somewhat cup- or saucer-shaped (calyx meaning a cup), with, usually, five divisions (the sepals). This corresponds in position to the pappus of the dandelion. If we could examine many kinds of composite flowers, we would find many gradations in form between the calyx of the buttercup and the pappus of the dandelion. Hence the botanist assumes that the two correspond, but are modified in the two plants, because they have a different work to do, or have different functions. The corolla, or "little crown," instead of being composed of one piece united into a tube at the base, as in the dandelion, consists of five or more yellow parts (the petals), together forming the most attractive and crowning feature of the flower. Within the corolla, and above the base of the petals, are many yellow parts (the stamens), each with its thread-like base (the filament) and enlarged upper part (the anther), but all

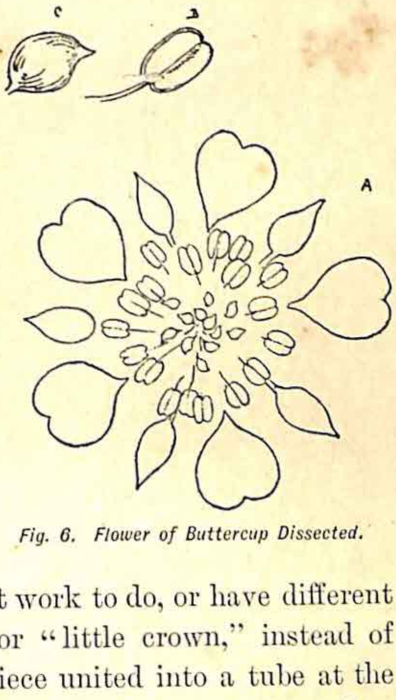


Fig. 6. Flower of Buttercup Dissected.

separate, instead of being united to form a ring or tube, as in the dandelion. In the centre of the buttercup flower is a mass of green bodies which careful examination shows to be seed-vessels, or pistils, each containing one seed, but without any style, and without any hairy attachment above. Unlike the dandelion floret, in its great yellow cluster, each buttercup flower stands alone, growing directly from the upper end (receptacle) of the flower-stalk. The dandelion and buttercup flowers have the same parts, but the arrangement of these parts is very different in the two.

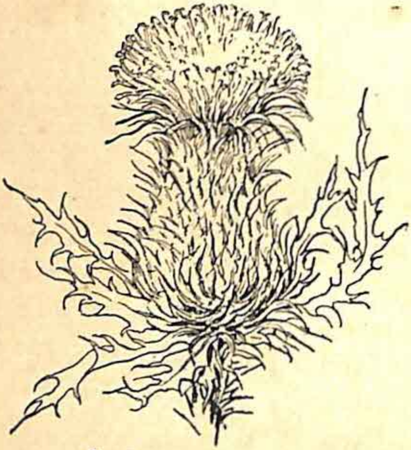


Fig. 7. Blossom of Thistle.

When we compare the dandelion and the buttercup with the common thistle (see Figs. 7 and 8) we find that the roots, stems, and leaves of all three are very unlike, and at first sight the flower of the thistle seems unlike those of the other two plants. A careful study, however, shows a cup-shaped, spiny involucre, similar in position, but not in appearance, to that of the dandelion, composed of many parts united or grown together. Within this spiny cup is a large number of little flowers (see Fig. 8), differing from those of the dandelion in shape, but like them in having a minute one-seeded ovary, a pappus and corolla, five stamens with anthers grown together, and a long, slender style. The corolla is tube-shaped, with five long, slender teeth, not strap-shaped as in the dandelion.

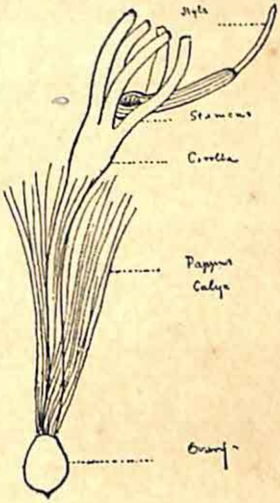


Fig. 8. Single Flower (Floret) of Thistle, Enlarged.

If we continue by comparing the three already studied with the anemone, — wild anemone during spring or summer, and garden anemone (see Fig. 9) during the fall, — we find that the buttercup, while quite unlike the anemone in general appearance, has flowers with similar parts, but without a calyx, arranged in the same way.

We are led by this comparison to put the dandelion and thistle together, and the buttercup and anemone together. We learn from the books that the first two belong to the composite family of flowering plants, and the last two to the crowfoot family. We have compared our dandelion with other forms of plants, and placed it in a class with plants closely resembling it; that is, we have, to some extent, classified it.

What is the educational value of comparing and classifying different forms, as compared with the educational value of studying the dandelion as a form by itself, unrelated to other plant forms?

First. We have broadened our knowledge of plant forms by studying several plants.

Second. We have increased our interest in the structure of plants by studying variations in form and structure.

Third. We have learned to use our powers of observation more accurately.

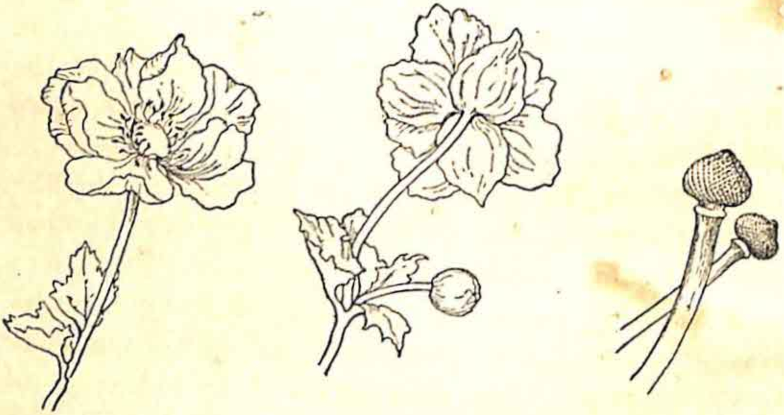


Fig. 9. Anemone Flower and Fruit.

Fourth. We have learned to express ourselves better; to increase our power of telling what we see and know.

Fifth. We have developed our power to compare, to discriminate between essentials and non-essentials in structure, to group and classify. We have learned to think, as well as to see and tell, and so to arrange or relate our thoughts that one thing shall stand in our minds as a type of many.

Yet even in studying the dandelion as a plant form in relation to other forms of plants, have we accomplished what will be of the highest educational value? Most of the work in botany in our secondary schools consists of this study and description of plant forms, and comparison with other forms, or tracing through an analytical key, and finding names, which is supposed to be comparison.

Will such work meet the needs of the boys and girls in the elementary schools? Is interest in nature, and power to see and compare and classify and describe, the highest pleasure or value they can get from nature study?

Is there anything better about the dandelion for the children to study than its form, and its relation to other plant forms, like and unlike it?

In addition to what we may call its form, or structural relations, it has other relations to its surroundings or environment. It is a living thing, dependent on its physical environment, — soil, moisture, air, sun; helped or harmed by these. It is adapted by form and structure and life-processes to get help from these and to give help to them in return. Let us study the relations between our dandelion and its physical environment, its dependence on its environment, its adaptation to its environment.

Our dandelion when separated from Mother Earth very soon wilts and dies, unless kept in a damp place or in water. It is dependent on the soil and on the moisture in the soil, and this moisture it must get from dew and rain and cloud. It thrives only where it can get the sunlight; opens its yellow eye to the sun each morning, and closes it at night; pushes its leaves up above the grass, and out from the shade of stone and fence; evidently it depends on the sun. If it is deprived of air, it dies, much as we should; it depends, then, on the air. The hairy sails on its seeds would be useless without wind to carry them along. It spreads in its flower a feast of nectar, which attracts hosts of insects. It certainly helps the insects; we shall find that the insects help it. The dandelion may be eaten by animals and destroyed by man. Our dandelion depends, then, on soil and dew and rain and clouds; on sun and air and wind; on insects and other animals; and on man. If we could study it thoroughly, we should find it more or less dependent on a host of other agencies; in fact, on all, or nearly all, of its physical environment.

If it depends on these, it must be fitted to get help from its physical environment, or to struggle against it. Let us take up its parts in order, studying them not as mere forms, but as organs for sustaining life, investigating not merely their structure, but their special function and adaptation to their environment. Let us constantly ask not merely "What?", but "Why?" and "How?". We shall have to study carefully; not merely observe, but think.

Beginning with the roots, if we very carefully dig up from soft soil a root with all the earth about it, and cautiously wash off the soil by moving the mass back and forth in a pail of water, we shall discover many

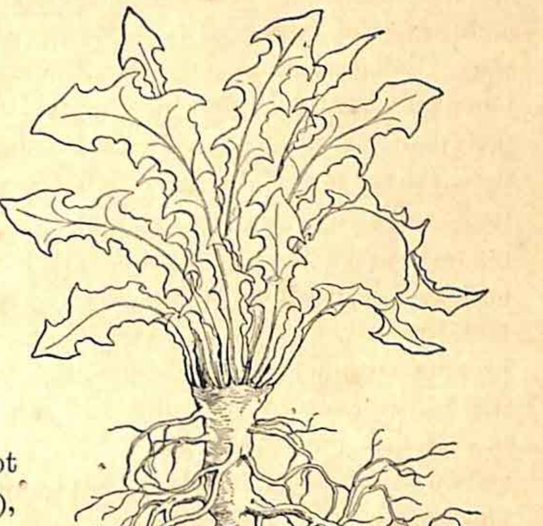


Fig. 10.
Roots and Rootlets of Dandelions.

things that were overlooked before. (See Fig. 10.) When we merely pull up or dig up a plant, and shake off the earth, we see very little of the root system. Besides the strong central root, or tap-root (shown in Fig. 1), we now discover a multitude of branches, many of them very minute, spreading widely in all directions. What are they and the strong tap-root for? Any boy who has tried to pull dandelions will tell us that the strong root holds the plant firmly in the ground; it is almost impossible to pull it out. Of how little value the minute roots are for this purpose! If we dig up a root before the plant has gone to seed, it is full of milky juice. A root of a plant which has formed and ripened its seeds is spongy, and has little of the milky fluid. The inference, confirmed by careful study, is that this strong, fleshy root is not merely a holdfast, but a storehouse of food to perfect the seeds. We see here one way in which the dandelion is adapted to get the most from its environment, and one reason why it flourishes in the midst of and in spite of drought. It has made provision for such contingencies, has a store laid by for a dry day. What do the fine rootlets do? If the roots of a dandelion plant possessing these fine rootlets are kept immersed in a jar of water, the plant will grow for weeks, developing its flowers, and ripening its seeds. Without these rootlets, with only the tap-root, it dies much more quickly. This indicates — what is confirmed by further experiments — that the fine rootlets take in or absorb from the soil moisture and the plant food dissolved in it. By keeping the roots of our dandelion plants in water containing measured quantities of various mineral substances dissolved in it, we could readily ascertain that the dandelion absorbed through its rootlets certain minerals in certain proportions, and refused to absorb other substances. The rootlets not merely absorb, but they select. We might discover also, by experiment, that the rootlets, and particularly their tips, show something akin to sensation and intelligence in the character and direction of their growth in the ground. The root tip is so sensitive that Darwin has compared it to the brain of lower animals.[1]

---

[1] See Darwin's *Power of Movement in Plants;* or Newell's *Reader in Botany,* Part 1, p. 34.

The roots of the dandelion are then adapted to their environment:—

First. By having a strong, tough tap-root to serve as a holdfast.

Second. By having a thickened, somewhat fleshy root to serve as a storehouse for food.

Third. By having a multitude of hairy or fibrous rootlets, with many branches growing out in all directions, to absorb moisture and food from the soil; these are fitted, by their manner of growth and sensitiveness, for their work of absorption.

The dandelion root is, then, more than a "cylindrical or conical tap-root, exogenous, with a milky liquid." It is a holdfast, a storehouse, a purveyor and absorber of food for the plant.

The leaves we have described as "radical, alternate, runcinate, pinnately veined, glabrous." Is that all? Let us ask not merely, "What are they?", but, "What do they do?". They grow from the upper end of the tap-root (apparently), forming together a circle: this is flat on the ground, or saucer-shaped; or, in high grass, cup- or cone-shaped. (See frontispiece.) The leaves alternate so as to leave few open spaces, yet do not cover one another. Nearly all of each leaf is exposed to the sun. If we watch them in a rainstorm we shall see that they are so arranged that nearly all of the rain which falls on them is directed downward and inward toward the root. The arrangement of veins (*venation*) aids in this. The veins are a system of troughs, or ditches, directing the water to the root. The leaves, then, are adapted by position, arrangement, and veining to direct water toward the roots.

Clustered between their broadened bases, often wrapped about by them, are tiny leaf and flower buds. The leaves help to protect these.

The leaves are not merely arranged so as to give each leaf as much sunlight as possible, but those in high grass grow up toward the sun, and those in shady places grow out from the shade toward the sun. Evidently they have some reason for seeking the sunlight.

If we cover a small growing dandelion plant with an inverted glass tumbler or fruit can, we soon discover, if the plant is in the sun, little drops of moisture on the inner surface of the glass; if in the shade, the moisture appears more slowly. By preventing the passage of moisture from any part of the plant except the leaves (spreading paper over the ground under the leaves), we can show that the moisture comes from the leaves. We learn that the leaves throw out much of the moisture absorbed by the rootlets, and that the sun or sunlight aids them. They are adapted to throw out moisture by their form, — broad and thin, with a very large surface. By their position and arrangement, with nearly all of every leaf exposed to the sun, they get the greatest possible help from the sun. The skin (*epidermis*) with which they are covered prevents too rapid escape of moisture. Microscopic examination shows great numbers of little openings in the skin (breathing-pores, or *stomata*), which have the power of closing and opening,

~~8279~~

and thus regulating the escape of moisture in dry or wet weather.

It can be shown that the leaves breathe or respire for the plant in a way corresponding to our lungs, and that they also take in gaseous food from the air, and convert this and part of the water absorbed by the rootlets into starch and other plant foods. For the latter process they need the help of the sun. For this work they are adapted by their position and arrangement, exposing them to the sun, and by their form, with great extent of surface, through which the gases can pass, and on which the sunlight can act. Their effort to change position by bending away from the shade and toward the light, and their greater length in high grass or shaded places, aid them in getting help from the sun. The strong veins, with branches on each side, extending into the tip of each division or lobe, aid in lifting and supporting every part of each leaf in the sunlight, as well as in directing water to the roots, and in carrying water and dissolved food into every part of the leaf.

Now, the form and structure of the dandelion leaf mean something. We begin to see a reason for the structure in the adaptation to surroundings or environment.

The leaves of the dandelion are adapted by their position, arrangement, form, venation, and movements:—

First. To direct water to the roots.

Second. To protect buds at their base.

Third. To throw out water, with the aid of the sun.

Fourth. To breathe.

13.8.93
7262

Fifth. To absorb gases and make plant food, with the aid of the sun.

Wonderful as is the flower considered as a structure, it becomes much more wonderful when studied as a living thing, an organ with a work to do, an adaptation to work and environment.

In particular the slender, hollow flower stem is an admirable illustration of adaptation to work or function. In the bud it is very short, lengthening, as the flower develops, just enough to push the blossom above the grass, and later lengthening much more to lift the plumed seeds up where they will catch the wind. The length of the stem depends largely on the height of the grass or other plants about it; in tall grass it may push up two feet or more to lift flower and seed above surrounding plants. In the late autumn, when little is to be gained and much may be lost by lifting up the flower, the flower stem, or scape, remains very short. It bends away from shady places. Its structure, a hollow cylinder, gives the greatest strength and flexibility with the least material.

The scape not merely lifts the seeds up into the wind, but when they are ripe the rapid change in the form of its upper end, or receptacle, from a shallow cup to a somewhat flattened ball, causes the seeds attached to it to spread out into the hairy sphere, and exposes every seed with its little parachute to the wind. (See frontispiece. Compare Figs. A, 5, and B.)

The scape has one duty, to hold up the flower toward the sun, and where it will attract insects, and to lift up and spread out the seeds where they will catch the wind. When this work is done, it shrivels and dies.

No less interesting as a study in adaptation to environment is the involucre, with its rows of alternating, overlapping bracts. Note how all the rows of bracts protect the buds (see frontispiece, Fig. A, 1); how, as the flower develops, the outer rows are turned back or reflexed, while the inner row closes over and protects the flower at night, and often during storms, opening in the morning or when the sunshine returns; how finally it remains closed about the flower, sometimes for several days, while it is perfecting its seeds (see frontispiece, Fig. A, 3); how as the beak elongates and pushes up the pappus, this inner row of bracts also elongates and protects the developing seeds and their growing wings or parachutes, until the change in the form of the receptacle begins to push the seeds apart. Then the inner row of bracts is also reflexed.

The work of the involucre, to protect bud and flower and undeveloped seeds from excess of moisture and sudden changes in temperature, is now done, and, with the scape and receptacle, the bracts shrivel and die.

Is not the involucre more than "three rows of imbricated bracts, the inner row erect, the outer rows reflexed"? Is it not almost intelligent? Does not its structure embody a thought?

If we are not satisfied with describing the blossom and hairy fruit as two distinct things, but patiently watch the process by which the flower changes to fruit, constantly asking why and how, we shall learn much which we can never discover from a mere pulling to pieces for analysis and description. Let us mark several buds and flowers with a string or label; and note carefully, two or three times a day, the changes in them. We shall see the lengthening of the scape and the protective closing of the flower, and the changes in the length of the bracts. We may note the numerous insects which visit the blossom. We shall discover that after the blossom finally closes, the yellow part shrivels, is lifted up, and at last drops off. At the same time the hairy pappus is very gradually pushed up, at length protruding above the bracts (as in frontispiece, Fig. A, 3), the hairs of the pappus, lying pressed close together, separate, somewhat as an umbrella opens, the bracts are bent outward and downward or reflexed, and the hairy stems supporting the pappus of each flower diverge, and we have the spherical fruit of the dandelion. Why? How?

As we watch this in the wind, or imitate the children as they try to discover, by blowing the seeds, "what time it is," or whether "mother wants me," we see the seeds sail away, each with its little parachute, settle down, and gradually work down into the grass.

Are the yellow blossoms, the "seals of gold in the meadows," "bright as if Night had spilt her stars," are they merely "flowers arranged in a close head, with an involucre of three rows of imbricated bracts"? Why lifted up so high? Why such a bright color? Why and how do they open and close? How do they perfect their seeds, and lift up and spread out their fruit, the "spherical open hairy clusters" we have described?

Let us examine one little flower of the dandelion, asking constantly "why," and "how." Each seed has a little stem (the beak) connecting it with the parts of the flower above. Why? If we have watched the fruit develop, we have discovered that this beak lengthens, pushes up the pappus, forms the rays or radii of the sphere, and is the rope connecting each seed with its parachute.

Why does each dandelion flower have its outer part, or calyx, composed of little hairs, while in the buttercup it is composed of little green leaves? Each is fitted for its work. In the buttercup the calyx protects the parts within; in the dandelion the involucre protects, and the calyx has another duty, — to scatter the seeds.

What is the use of the other parts, — corolla, stamens, and style?

In the dandelion, as in all other flowering plants, seeds — that is, perfect seeds which will develop into plants — are formed, and only formed, by the union of the pollen (the yellow powder coming from the anther, or upper part of the stamens) with rudimentary seeds or ovules in the ovary, or lower part of the pistil. The grains of pollen must in some way pass from the anther to the upper portion of the style, called the stigma, from which some of the living matter (*protoplasm*) in the pollen grains works down through the style into the seed-box, or ovary, and unites with the rudimentary seeds there. Not until this process (*fertilization*) takes place will these rudimentary seeds begin to develop into real seeds, capable of forming new plants.

It is a law of nature that better seeds are produced when the pollen from one flower is carried to the stigma of another flower of the same kind; that is, when there is what is called *cross-fertilization*. Seeds may be formed when the pollen of a flower gets on and pushes into the pistil of the same flower, but this process of *self-fertilization* is not apt to produce as healthy, vigorous seeds or plants as does cross-fertilization. It is to the interest of most flowers, including the dandelion, to prevent self-fertilization, and secure cross-fertilization as much as is possible.

We shall find that the structure and changes in corolla, stamens, and pistil are arrangements or adaptations to insure cross-fertilization, if possible; otherwise, self-fertilization. In cross-fertilization the pollen is most commonly conveyed from the stamens of one flower to the stigmas of other flowers, either by insects or the wind. The dandelion hires the insects to carry her pollen from flower to flower.

The corolla has the special duty of attracting the insects by its bright color (one reason why the blossom is pushed up above the grass), and by the honey, or nectar, at its base. From the nectar and from the pollen, of which the dandelion and other flowers produce much more than they can use, the provident insects get their store of food. The bright-colored corolla is the signboard telling where these can be found. In getting them the insects brush off and carry on the hairs on various parts of their body more or less pollen, some of which adheres to the somewhat spongy and sticky surface of the stigmas of other flowers. The flower tries to prevent the pollen of any flower from coming in contact with, or adhering to, the stigma of the same flower, and to insure its adhering to the stigma of another flower.

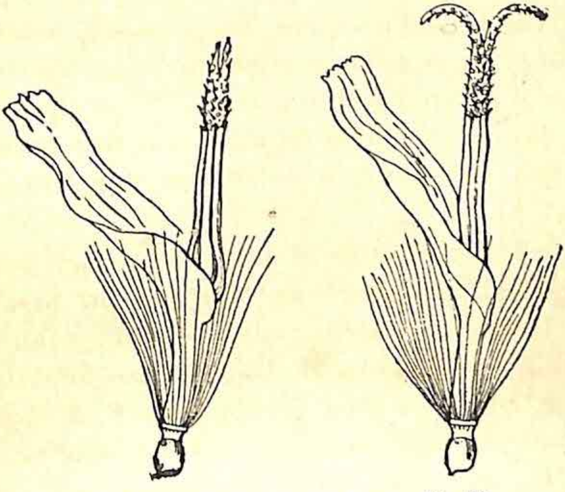


Fig. 11. Fig. 12

Floret of Dandelion; Arrangement for Cross-Fertilization.

To insure this cross-fertilization, the anthers of the dandelion (see Fig. 11) ripen before the style or stigma is mature, and discharge the pollen into the tube formed by the union of the anthers. The style then lengthens, and minute hairs on it push or carry the pollen above the anther tube. Later the stigma ripens, and its two parts separate and curve outward (as in Fig. 12), each division having on its inner upper side the spongy, sticky surface on which the pollen must fall in order to develop. When the insects visit the flower in search of the nectar at the base of the corolla, and come in contact with the pollen, they carry some of it away. Even if the pollen grains come in contact with the outer and under surface of the recurved stigma, the grains are not apt to adhere, and will not develop. When the insect visits a new dandelion flower, and brushes against the upper inner surface of the forked end of the style (as it is almost compelled to do when pushing its proboscis, or mouth parts, into a flower), some of the pollen may adhere, develop, send its protoplasm down through the style, fertilize the ovule, and insure the development of the seed.

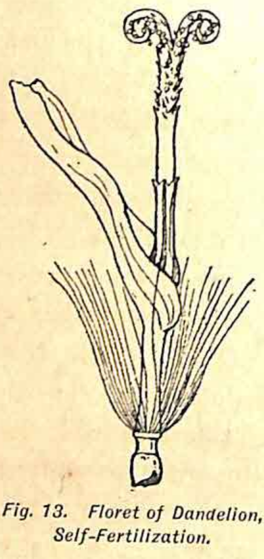


Fig. 13. Floret of Dandelion, Self-Fertilization.

If, for any reason, cross-fertilization is not secured, then the two divisions of the style bend downward and outward (see Fig. 13), each curving into a circle, and bring their inner spongy surface in contact with the pollen above the anther tube, thus insuring self-fertilization and the development of their ovules.

When fertilization has been secured, the work of corolla, stamens, style, and stigma is about completed, and they soon shrivel, and are pushed off by the growth of the beak.

In two days or more, depending on weather and temperature, after the florets have been fertilized, and the dandelion blossom has finally closed, the pappus of each flower is pushed, by the lengthening of the beak, above the enclosing involucre; the receptacle becomes convex instead of concave (compare Figs. B and A, 5, in frontispiece), causing each pappus to separate from all the others, and the hairs to spread out like an umbrella inverted, and we have the "hairy open spherical head," each seed with its balloon spread ready to catch the wind and sail away. The dandelion mother shows no favoritism. She gives each seed baby a choice seat on her tower, from which to view the world and take flight.

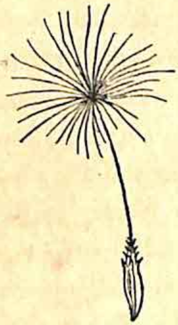


Fig. 14.
Seed of Dandelion.

Mother Dandelion's care for her seeds does not end with the arrangements for their dispersal by the friendly wind. Not merely does she provide each seed with a balloon, or parachute, but to each she gives a set of grappling irons to anchor again to Mother Earth. If we examine carefully (see Fig. 14), we shall find about the upper end of each seed many little spines growing obliquely outward and upward. As the seed, after its flight in the air, settles down, these spines catch in the grass, and then the swaying of the parachute causes the seed to work deeper and deeper into the grass. If it alights on rock or hard soil, it is not so apt to catch, but may be carried farther, to a more promising landing-place.

It would seem that Mother Nature or Mother Dandelion was thinking, when she gave the seed its color, how much better it would escape the sharp eyes of birds and insects if it had the color of the ground where it must rest for months.

When we study the dandelion in this way, asking "why" and "how" as well as "what," investigate the work of its parts as well as their structure, what do we gain from it? What is the educational value or aim of such a study of the functional relations of the dandelion to its environment, of its dependence on and adaptation to environment, as compared with the value of the previous study of its structure and structural or form relations?

First. Our interest in the dandelion is greatly increased. We have studied it not merely for its form, but as a plant endowed with life. We have given it a personality somewhat akin to ourselves, and watched its struggles and perseverance and triumphs. We begin to feel some sympathy for the domestic weed. This is particularly true of children, to whom living nature appeals so strongly.

Second. Our appreciation of the beauty of the dandelion, which may have begun with the study of structure, increases greatly as we learn to see not merely the beauty of form and color, but the far higher beauty of function and adaptation. "Handsome is that handsome does," is as true for the dandelion as for any of the human kind.

Third. We have laid some foundation for realizing the mutual dependence and helpfulness of all nature, and for comprehending the unity of nature. The dandelion has become more than something with root, leaves, flowers, and seeds. It has become a unit, with all its parts related, and a centre about which much of its physical environment has been grouped.

Fourth. We have learned to think as well as to see; to investigate the "why" and "how" as well as the "what" of the dandelion. We have learned somewhat better to see or think of things in all their relations, functional as well as structural, relations of dependence as well as relations of similarity and difference. We have developed somewhat our capacity for broad thinking.

We have studied the dandelion as an isolated form or structure; we have compared it with other forms of plants; we have considered its dependence on and adaptation to its surroundings. Have we exhausted its relations, — studied them all? Have we put into or obtained from the wayside weed all that may make its study of educational value, — all its content?

Does the dandelion have any relations to man, or any higher relations? To our practical, matter-of-fact reader may come visions — or nightmares — of the intensely bitter dandelion tea administered in childhood days by mother or grandmother as a "spring medicine." Perhaps we remember with more pleasure the dandelion greens made from the young leaves. So the dandelion is of some use to man.

It may be that we recall the persistent but often vain efforts to eradicate the dandelion from our lawn. Now that we understand better the resources of the plant, we are not much surprised that we were defeated in our struggle with it. Perhaps we have noticed how the dandelion accompanies man in his conquest over nature; seems to thrive best in the vicinity of man. It is, in some degree, dependent on or affected by man.

Are we still young enough, in heart, to enjoy telling time as we did in childhood, by seeing how many "blows" it takes to scatter all the seeds in a head; or, by a similar process trying to discover "whether mother wants us"? Perhaps we have not forgotten how to make dandelion curls and dandelion chains. The dandelions were close to us and dear to us in our childhood days.

Has the thought come to us that the despised wayside weed is more to man than medicine or food or a plant-pest or a plaything; that it may have a higher function or use for man? Have we appreciated the beauty of its contrasting green and gold, and the exquisite delicacy of its cluster of seeds? Why is it, like hosts of other weeds, so pretty? Its beauty is not essential for seed-making. Why is it that—

"Dandelion through the meadow makes
A royal road with seals of gold"?

Why is it that among the flowers, the

"Stars that in earth's firmament do shine," we find most frequently about our homes

. . . "the dandelions, bright
As if night had spilt her stars"?

Is it not because they are related to something higher in man than his physical or material nature? Have we really studied the dandelion with our children until we have helped them to appreciate its beauty; not only its beauty of color and form, but, far higher than these, its beauty of function and adaptation, the way in which it is fitted for and performs its work? The dandelion ministers to the æsthetic nature of the child. Indeed, unless the study leads to a fuller enjoyment of the beauty of nature, we have gained little from our nature study.

Longfellow has said, —

"In all places, then, and in all seasons,
Flowers expand their light and soul-like wings,
Teaching us, by most persuasive reasons,
How akin they are to human things."

As we study the mutual dependence and mutual helpfulness of all parts of the plant, as we discover how they help and are helped by insects and wind and rain and sun, do no lessons come to us, and even more strongly to our children, concerning our relations to the world about us? How akin to the child are the dandelion and the violet, of which Lowell writes, —

"For the whole year long I see
All the wonders of faithful Nature
Still worked for the love of me;

Winds wander, and dews drip earthward;
Rain falls, suns rise and set,
Earth whirls, and all but to prosper
A poor little violet."

The dandelion is a symbol of man. Its life is full of symbolism for the children. From the study of the plant, from what comes to the child through his eyes, the gateways to his soul, our boys and girls can better appreciate what they receive from their environment, and what they owe to it. Hans Andersen brings out these ethical lessons in "The Apple Branch," and in many other tales. Thus the dandelion may minister to the ethical nature of the child — and of his teacher.

We cannot do better than turn to Lowell's poem, "To the Dandelion": —

TO THE DANDELION.

Dear common flower, that grow'st beside the way,
Fringing the dusty road with harmless gold,
  First pledge of blithesome May,
Which children pluck, and, full of pride, uphold,
High-hearted buccaneers, o'erjoyed that they
An Eldorado in the grass have found,
  Which not the rich earth's ample round
May match in wealth, thou art more dear to me
Than all the prouder Summer-blooms may be.

Gold such as thine ne'er drew the Spanish prow
Through the primeval hush of Indian seas,
  Nor wrinkled the lean brow
Of age, to rob the lover's heart of ease;
'Tis the Spring's largess, which she scatters now
To rich and poor alike, with lavish hand,
  Though most hearts never understand

To take it at God's value, but pass by
The offered wealth with unrewarded eye.

Thou art my tropics and mine Italy;
To look at thee unlocks a warmer clime;
  The eyes thou givest me
Are in the heart, and heed not space or time:
Not in mid June the golden-cuirassed bee
Feels a more Summer-like, warm ravishment
  In the white lily's breezy tent,
His fragrant Sybaris, than I, when first
From the dark green thy yellow circles burst.

Then think I of deep shadows on the grass,
Of meadows where in sun the cattle graze,
  Where, as the breezes pass,
The gleaming rushes lean a thousand ways,
Of leaves that slumber in a cloudy mass,
Or whiten in the wind, of waters blue
  That from the distance sparkle through
Some woodland gap, and of a sky above
Where one white cloud like a stray lamb doth move.

My childhood's earliest thoughts are linked with thee;
The sight of thee calls back the robin's song,
  Who from the dark old tree
Beside the door, sang clearly all day long,
And I, secure in childish piety,
Listened as if I heard an angel sing
  With news from Heaven, which he did bring
Fresh every day to my untainted ears,
When birds and flowers and I were happy peers.

Thou art the type of those meek charities
Which make up half the nobleness of life,
  Those cheap delights the wise
Pluck from the dusty wayside of earth's strife;
Words of frank cheer, glances of friendly eyes,

Love's smallest coin, which yet to some may give
The morsel that may keep alive
A starving heart, and teach it to behold
Some glimpse of God where all before was cold.

Thy wingèd seeds, whereof the winds take care,
Are like the words of poet and of sage
Which through the free heaven fare,
And, now unheeded, in another age
Take root, and to the gladdened future bear
That witness which the present would not heed,
Bringing forth many a thought and deed,
And, planted safely in the eternal sky,
Bloom into stars which earth is guided by.

Full of deep love thou art, yet not more full
Than all thy common brethren of the ground,
Wherein, were we not dull,
Some words of highest wisdom might be found;
Yet earnest faith from day to day may cull
Some syllables, which, rightly joined, can make
A spell to soothe life's bitterest ache,
And ope Heaven's portals, which are near us still,
Yea, nearer ever than the gates of Ill.

How like a prodigal doth nature seem,
When thou, for all thy gold, so common art!
Thou teachest me to deem
More sacredly of every human heart,
Since each reflects in joy its scanty gleam
Of Heaven, and could some wondrous secret show,
Did we but pay the love we owe,
And with a child's undoubting wisdom look
On all these living pages of God's book.

But let me read thy lesson right or no,
Of one good gift from thee my heart is sure;
Old I shall never grow
While thou each year dost come to keep me pure

With legends of my childhood; ah, we owe
Well more than half life's holiness to these
  Nature's first lowly influences,
At thought of which the heart's glad doors burst ope,
In dreariest days, to welcome peace and hope.

We cannot stop with the æsthetic beauty and the symbolism and ethical lessons of our wayside friend. Everything about it points to its Source. It is one of "these living pages of God's book," a leaf in the "manuscript of God." Its form and structure and plan, and, much more, its life and adaptation or fitness for its place, point to its Maker. Unless we, and our boys and girls, look from nature and through nature up to nature's God, our study of the dandelion or of nature has missed its highest value. In this highest spiritual relation we discover that which illumines and relates and unifies all else.

Perhaps we can now better understand and appreciate the thought from Tennyson with which we began, —

"Flower in the crannied wall,
I pluck you out of the crannies;
Hold you here, root and all, in my hand,
Little flower — but if I could understand
What you are, root and all, and all in all,
I should know what God and man is."

CHAPTER II.

THE STUDY OF THE RABBIT.

An Introduction to Animal Study.

IN the previous chapter we have studied the dandelion as a type of the plant. We have approached it from the morphological or structural point of view, because that is the phase of the plant which has been most emphasized in the plant study of the past, and most teachers and adult students are apt to look at the plant from that point of view. We have shown how much richer and higher content there is in the investigation of the life and relations of the dandelion than in mere analysis, description, and classification. From some consideration of aims in nature study, we have been led to urge that the order commonly followed and the work done by older students in their plant study be modified in work with children, that they begin with and emphasize the observation of the life and function of the dandelion and its parts, proceeding from this to structure or adaptation, and finally to comparison and classification.

In this chapter we shall study the rabbit as a type of the animal. We will approach it from the standpoint of the child, not of the adult, and will follow the order of study indicated at the end of the previous chapter. This chapter is thus intended to illustrate, much more definitely than did Chapter I, method in nature study.

The domesticated rabbit is selected, because it is so common and so many children have made a pet of it and have observed its habits; because it can be easily obtained and kept and its life and habits can be readily observed in the schoolroom or school-yard; because a rich literature, mainly of folk-lore, has been gathered about the rabbit, and because it is an excellent type animal and starting-point for the study of its many relatives, the "gnawers" or rodents. Another good type animal easily studied is the cat.

Much of what follows is a gathering-up and summarizing of work in the writer's class in nature study methods in the Oswego State Normal school. The work of each class begins with a careful study of some common plant or animal, or both; this forms the concrete foundation for the work of the term. One class spent two weeks on the rabbit: observing (from live animals at the school) and writing about its habits; describing its structure and making drawings of the animal and of its parts; comparing it with the squirrel, rat, cat, canary-bird, and other animals, and thus classifying it; and finally searching the library to ascertain what others had discovered and written about their friend, and to gather all the folk-lore and other literature related to the rabbit. This was followed by a very hasty discussion of aims in the rabbit study, and of the order to be followed in the work with the children. Each member of the class was then expected to prepare an outline, very definite and specific, for the study of the rabbit with children of a certain age or grade in school, different sections of the class preparing outlines for the different grades, from the first to the eighth. Later some time was spent discussing and criticising these outlines. The writer wishes to acknowledge his indebtedness to the members of his class for many helpful ideas and suggestions, and for much of the related literature.

The plan of work and method followed in studying the rabbit depend: —

First. Upon the aim kept in mind: the cultivation of a sympathetic interest in the rabbit and in animal life, and through this a better appreciation of the beauties and uses and rights of the world of life; or a development of the intellect and intellectual powers of the child, training him to observe and think and express; or the acquisition of a mass of facts about the rabbit and animals in general. Aims in nature study are discussed in Chapters IV and V.

Second. Upon certain laws of mind: that the child depends upon his senses and mainly upon his eyes for real knowledge; that each new idea must be related to or incorporated with what is already in the child's mind before it becomes his mental possession; that the mind receives and retains ideas most readily when they are presented in order, step by step, each point clearly and deeply impressed before a new point is presented; that the child must arrange and give back, or express in some way, the ideas presented to him, to insure clear, definite ideas, and to develop the power of conveying ideas to others. These underlying psychological principles and their application are discussed in Chapters VII, VIII, IX, and X.

Third. Upon such conditions as the age and capacity of the children, the material obtainable for study, and particularly for comparison, and the importance of correlating the rabbit study with and making it helpful in other school-work. These are discussed in Chapters XI, XII, and XIII.

On account of the dependence of the child on his senses, we avoid mere talking or reading about the rabbit, the first and greatest fault in much nature work, and make every effort to have him see as much as possible; we emphasize and begin with and build upon that which he can see, and omit or merely touch upon and leave till later that which cannot be seen. Because of the necessity of relating the rabbit study to what is already in the child's mind, we begin with that in the rabbit which is most closely related to the life of the child and most appeals to him, and dwell on its home and home-life, its need of protection and the care of its young, and other characteristics which show "how akin they are to human things." To meet the demand of the mind for continuity of thought, each lesson has a central thought, but is related to the lessons preceding and following; each lesson is divided into two or more somewhat distinct steps, and the steps and lessons are carefully summarized, thus clarifying and clinching the important facts and thoughts, upon which new work must be based. Provision is made for expressive work, to lead the child to arrange and thus clarify his ideas, to give teacher and child a means of testing the clearness of the ideas gained, and to make the rabbit study helpful in other school-work.

The work has been planned for what are believed to be average schoolroom conditions. It is assumed that most teachers can, with some effort and trouble, obtain living rabbits, preferably from or through their pupils, and keep them or care for them for a few days in the schoolroom or school-yard. Without the living rabbits the study is of comparatively little value. The work is planned for intermediate grades, about the fifth or sixth year in school; suggestions are given for adapting it to younger or older pupils. The lessons, including the related reading and expressive work, are supposed to occupy from three-quarters of an hour to an hour. Much better results will be gained from long lessons two or three times a week than from short lessons (fifteen or twenty minutes) daily.

OUTLINE FOR THE STUDY OF THE RABBIT.

AIM.

General Aim. To awaken a sympathetic interest in and love for all animal life, so that the children will be kind and gentle in their dealings with animals; to help the boys and girls gain some realization and appreciation of the beauty and unity of nature, and of the care and plan shown in nature.

Minor Aims. To lead the children to observe the habits and structure of the rabbit, and see how they are adapted to its life and home; to enable them to gain definite knowledge which may be used in later work; to develop their powers of observation, expression, and thought.

MATERIAL.

Absolutely necessary are one or two living rabbits, in schoolroom or in school-yard, confined if necessary in boxes or cages enclosed in wire netting.

Helpful will be a box of sand in which the rabbits can dig or burrow, the skeleton or picture of the skeleton of a rabbit or of the rabbit's head, to show the gnawing and grinding teeth, and pictures illustrating their home and habits. Living or mounted specimens of at least two or three closely related animals, such as the squirrel, mouse, and rat, and of dissimilar animals, such as the cat, are necessary for good work in comparison and classification. Pictures will be helpful if the animals themselves cannot be obtained.

HELPFUL LITERATURE AND SUPPLEMENTARY READING.

1. Joel Chandler Harris's *Nights with Uncle Remus.*
2. Joel Chandler Harris's *Daddy Jake the Runaway.*
3. Cowper's Poems. *Epitaph on a Hare* and accompanying note.
4. Bret Harte's Poems. *Battle Bunny.*
5. La Fontaine's Fables. Translated by Elizur Wright.

6. William Hamilton Gibson's *Sharp Eyes. How Bunny writes his Autograph.*
7. John Burroughs's *A Year in the Fields. Winter Neighbors.*
8. John Burroughs's *Signs and Seasons. Winter Neighbors.*
9. John Burroughs's *Riverby. A Life of Fear.*
10. *St. Nicholas Magazine.* Old volumes.

Nos. 1 and 2 contain negro folk-lore, in which "Brer Rabbit" plays a prominent part. They contain much excellent supplementary reading, which can be read or told to children of any age.

In many editions of Cowper's poems is a note accompanying his poem, "Epitaph on a Hare," in which he gives a most interesting account of pet hares which he kept for several years.

Bret Harte tells in "Battle Bunny" how at the battle of Malvern Hill "a white rabbit, which had been hopping hither and thither over the field swept by grape and musketry, took refuge among the skirmishers, in the breast of a corporal."

Among La Fontaine's Fables are such as: "The Hare and the Frogs," "The Ears of the Hare," "The Hare and the Partridge," "The Hare and the Tortoise."

In *Sharp Eyes* Gibson tells how Bunny makes his tracks. In his book *Highways and Byways*, Gibson has a beautiful picture of the rabbit at home, called "A Winter Rendezvous."

John Burroughs tells in *Winter Neighbors*, found in both No. 7 and No. 8, a little about a rabbit which took up his abode under the naturalist's study floor, and much more about equally interesting animal neighbors and visitors. In *Riverby* he tells of the life of fear led by the rabbits and hosts of other wild animals.

The old volumes of *St. Nicholas* contain many excellent and well-illustrated rabbit stories for children.

Much on the habits and structure of rabbits, good for reference or supplementary reading, but lacking, usually, in literary value, can be found in books on zoölogy and natural history, and in the natural history readers for children.

ORDER OF LESSONS.

LESSON I. Home and Home Life.
LESSON II. Habits. Positions and Movements.
LESSON III. Habits. Feeding, Washing, and Senses.
LESSON IV. Literature and Folk-lore Related to Life and Habit.
LESSON V. General External Structure. Body and Limbs.
LESSON VI. General External Structure. Head, Ears, Teeth.
LESSON VII. Comparison and Classification. "Gnawers" or Rodents.
LESSON VIII. Comparison and Classification. Vertebrates and Mammals.

PREPARATORY WORK.

Have two rabbits in a large wire cage in the schoolroom several days before beginning formal work. The observation of habits, on which much later work is based, requires time. Have, if possible, a large tray of sand in one corner of the schoolroom; occasionally let the rabbits out in the room.

Too much emphasis cannot be placed on the necessity of *personal observation of the rabbit by the teacher*, as well as by the children. The teacher who prepares by merely reading about the rabbit cannot lead her children in observation. The teacher who depends on the book will almost certainly have pupils who depend on the teacher and book.

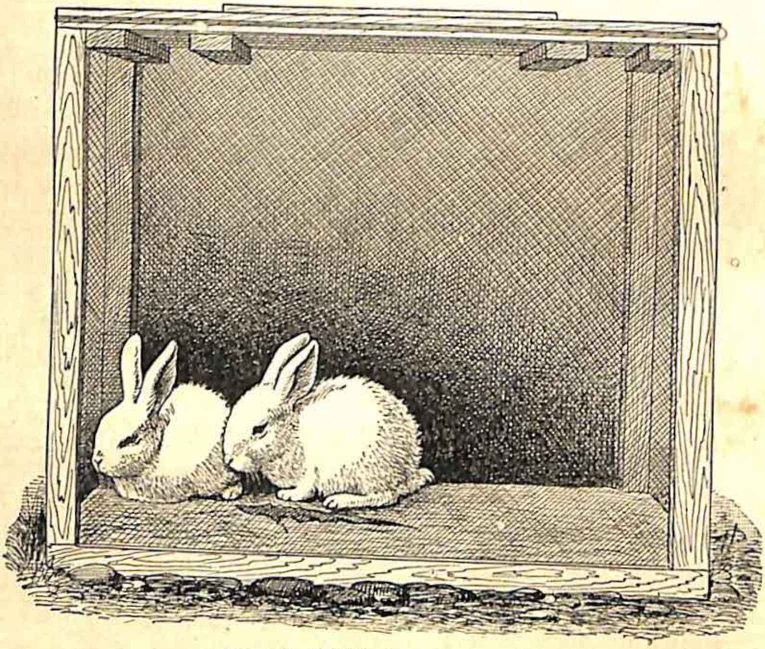


Fig. 15. Rabbits in Schoolroom Cage.

Have pupils care for rabbits as far as possible. Feed three times a day. "In the morning give them a handful of hay or dry clover, and a little of such green food as is in season; about noon, some good oats or meal; at night, more green stuff and hay, if that which was given in the morning is all eaten. Rabbits are very fond of green food, but do not let them have too much, and care should be taken that this is quite dry. No green food is better for rabbits than parsley and the tops of carrots; the roots of the latter are eaten with much relish. Besides these, lettuce, the leaves — or better still, the stumps — of a cabbage, turnips and parsnips, can sometimes be given them." It is commonly believed that rabbits do not need water. They certainly do, at least when their food is dry, and when they have young rabbits to be fed.

Find out how many of the pupils have or have had rabbits, and get them to watch their pets at home, and come prepared to tell something definite they have discovered about them. Strongly emphasize the idea that only the *observations* of the children are desired, not what they have heard or read about the rabbit.

Dwell on observation of habits, the study of which requires most time. Much about structure will be learned incidentally; the definite study of points of structure can be left for the formal lessons. Direct the observations by placing on the blackboard or giving to the pupils, from day to day, such questions as the following, to be investigated whenever the children have or can be given opportunity: —

Position. What is Bunny's position when lying down or sleeping? Where and how are his legs placed? His ears? Does he lie just as the cat, or dog, or cow, or horse does? Are his eyes tightly closed when he is asleep? How does he sit? How does he stand when watching or waiting for food, or when listening?

Movements. How does he move about his cage? About the room? (Observe carefully and tell exactly.) How many ways of moving about does he have? (Walking, hopping, and jumping.) Does he make much noise when he moves about? Why? Notice the kind of tracks he makes (in damp sand, or, in winter, in snow. See Gibson's *Sharp Eyes.*) How does he dig holes in the sand?

Eating. What does the rabbit eat? How? Have the children feed him. How does he gnaw the wood of his cage? Are his teeth like any of your teeth? Are they all alike? What is peculiar about his upper lip? (The cleft.) Watch him eating, and see the use of this kind of upper lip.

Senses. Watch the movements of the rabbit's ears, particularly when there is a sudden noise, and observe their position at different times. Does he move them as the horse does? What is the use of having them so large? Can he hear well? Can he see well? Watch Bunny's nose, particularly when food is brought near. Can he smell well?

Cleanliness. How do the rabbits keep clean? Watch them wash themselves and one another, and find exactly how they do it. Do they wash just as the cat does?

Breathing. Put your hand on your chest, and notice how it moves when you breathe. When does the chest move out or expand? When move in or contract? How many times a minute? Watch the breathing of the rabbits, and compare it with your own.

Burrowing. If possible, give the rabbit a chance to burrow in the yard or in a box of earth, that pupils may see how he does it.

Disposition. Are the rabbits fond of one another? Watch and see what they do to and for one another. (Play and eat together, wash each other's faces, go to sleep close together. Do they fight one another? Are they gentle or rough? Are they timid or easily frightened? Are they trustful when we are kind to them? Are rabbits all alike in disposition, or does each have his own traits, just as boys and girls do? Try to discover the distinctive traits of disposition of the rabbits under observation. See also note by Cowper, referred to under Helpful Literature. The confidence of a wild rabbit in man is brought out in Bret Harte's "Battle Bunny."

LESSON I.

Homes and Home Life.

Special aim. To broaden the sympathy and knowledge of the children by helping them to see some of the points of similarity between the homes and home life of the rabbits and of themselves, leading them from the domesticated rabbits to the less familiar wild rabbits; to lay foundations for the study of habits.

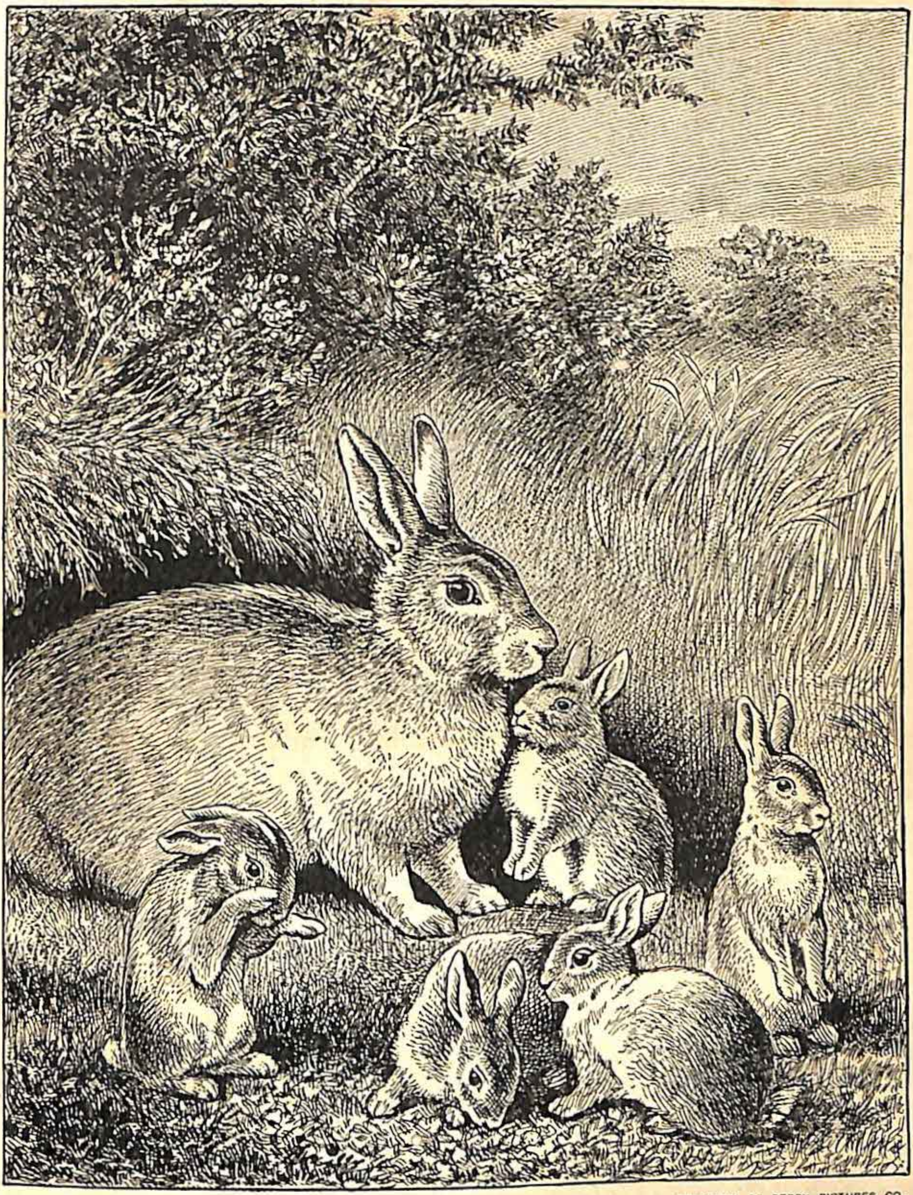
Aim given to the pupils: To-day we are going to find out all we can about Bunny's home.

Material needed. A box of earth in which Bunny can burrow, and pictures of wild rabbits in the woods, or even of the woods alone: pictures of the burrows of rabbits or other similar burrowing animals, such as the prairie dogs, will be helpful in impressing the ideas. Some beautiful pictures of rabbits at home can be found in Gibson's *Highways and Byways* and *Sharp Eyes.*

STEP I. *Domesticated rabbit's home.*

To give the children the right point of view, it may be well to begin the lesson by asking some of the pupils, those with good homes, about their homes, bringing out briefly the necessity for protection from rain and cold, and for food and care; the special care given to the children, and, most of all, to the baby; the mutual love, helpfulness, and forbearance, which really make the home. Now let us study the rabbit's home. Its home is certainly not here in the school-room.

The homes of the rabbits. Where and how they are kept. (In cages or loose in yards.) The construction of the houses or cages, to insure protection, fresh air, and cleanliness. Use of cages in protecting rabbits from weather and from animals from which they cannot protect themselves. Contentment in these when Bunny is well fed and cared for. How they escape from them by gnawing the woodwork or burrowing under the walls. How, when loose, they sometimes make burrows for themselves, or hide under buildings or in brush piles or under low-branching shrubs and trees or in tall grass.



COURTESY OF PERRY PICTURES CO.

RABBITS AT HOME.

Care of rabbits. Importance of cleanliness. Feeding them. What, how, when? Importance of often giving them their liberty, letting them run about. How they appreciate kindness shown them; how affectionate and trustful they sometimes become. (See Cowper's account of the treatment of his hares.)

Home life. How affectionate they usually are. How pleased to be with one another when placed together after separation. (It is often asserted that a rabbit, accustomed to the company of others, will pine and soon die if kept alone.) How they huddle together when resting or asleep. How they play and frolic together, particularly when let loose. Their scrupulous cleanliness, usually; how they wash themselves and one another. Their care of their young.

Summary. Have a definite oral summary with as few questions as possible, having two or more pupils tell all they can and as clearly as they can about each of the following points:

The homes of the tame rabbit.

How we should care for the rabbit, and how they show their gratitude for our kindness.

How the rabbits love and care for one another.

STEP 2. *The homes from which the rabbits first came.*

The rabbits were not always pets. Like the horse and cat and dog, and all our domestic animals and pets, they were once wild.

Why made a pet. Review those characteristics brought out in previous step, which make the rabbit a good pet; its tameness; its cleanliness; the comparative ease with which it can be cared for, on account of the nature and variety of its food. In Europe millions are raised every year, and sold for food; their skins and fur are also largely used.

Their original homes. Wild rabbits have been found for thousands of years in the warmer parts of Europe, Asia, and Africa. No true rabbits occur in America, except those which have been brought here. What we call wild rabbits are really hares. Have these regions located by the pupils on the maps, if they are old enough to use maps. Try to picture the homes of the wild rabbits in the woods and fields, and their free life as compared with that of their tame cousins.

Their houses. They have no boys to make houses for them; they make their own by burrowing. The tame rabbit in a box of earth or loose in the yard may show how the rabbits dig their burrows. The burrows are said to be in a zigzag, to make it harder for other animals to get in; in the side of the hill, when possible, to facilitate the removal of the earth, and to have several openings for escape. Because of the social instincts of the rabbits, many burrows often communicate, forming a "warren," in which scores may live together. The mother often digs a special burrow for her young, trying to find a dry place in light sandy soil, enlarges the bottom for a "nursery," and pulling hair from her own body, makes, from it and dry leaves, a comfortable bed for her babies. It is said that she often remains with them two days without any food. When hunger compels her to go out, she carefully covers the opening.

Their home life. "In its wild state the rabbit is an intelligent and amusing creature, full of odd little tricks, and given to playing the most ludicrous antics as it gambols about the warren in all the unrestrained joyousness of habitual freedom.

"At one time they are gravely pattering about the doors of their underground homes, occasionally sitting upright and gazing in every direction, as if fearful of a surprise, and all behaving with the supremest gravity. Next moment some one gets angry and stamps his feet fiercely on the ground as a preliminary observation before engaging in a regular fight. Suddenly a whole party rush off at full speed, scampering over the ground as if they meant to run a mile, at least, but unexpectedly stop short at an inviting tuft of herbage, and nibble it composedly as if they had not run a yard. Then a sudden panic will flash through the whole party, and with a rush and scurry every rabbit leaps into its burrow and vanishes from sight like magic. The spot that was so full of life but a moment since is now deserted and silent as if it had been uninhabited for ages; but in a few moments one little nose is seen cautiously poked out of a burrow, the head and ears follow, and in a very few minutes the frightened rabbits have come again into the light of day, and have recommenced their interrupted pastimes." (From *Animate Creation.*)

Their enemies. They are found in every direction: owls and hawks swoop down from above; weasels, foxes, hedgehogs, and the domestic cats catch them in or dig them from their burrows; man (the most cruel of all, because he kills them for mere sport and not to satisfy his hunger) chases them with hounds. Appropriate here will be a story illustrating the occasional sagacity of the rabbit in outwitting the hounds, or a story from *Nights with Uncle Remus*. See also *A Life of Fear* in Burroughs's *Riverby*.

Their food and the damage they do. Often kill young trees by gnawing the bark. When abundant, are very destructive to vegetation, sometimes making it impossible to raise crops. In some countries, such as Australia, where they were introduced as pets and have multiplied enormously, great hunts, with hundreds of men, are organized, and the rabbits are killed by thousands.

Summary. Have several pupils summarize the points discussed, emphasizing their burrows, warrens, and home life.

STEP 3. *The home of the hare (usually called the "wild rabbit") of our country.*

Any of the pupils who have lived in the country or have passed much time in the woods can probably tell something about the "wild rabbit." Depend on them as much as possible.

How distinguished from rabbit. The hare always has longer ears, longer than the head; in the rabbit the ears are shorter than the head. The common species are considerably darker in color than the rabbit, at least in summer, the more common one being yellowish brown in summer and gray in winter (hence called by the early settlers "gray rabbit," a name still used); another reddish brown in summer and whitish in winter (pure white in the far north), with ears tipped with black. The "gray rabbit" can often be obtained at the markets in winter; it is largely used for food. Common in the west is the "Jack Rabbit."

Home. Occurs in most or all sections of the United States. Does not burrow, but only makes a slight depression in the ground, usually under a tuft of grass or fern or a low bush or a pile of brushwood, in which the hare lies so flatly pressed to the earth and so closely resembling in color the soil and dried herbage that it can hardly be distinguished from them. To this simple home, or "form" as it is called, the hare seems much attached.

Home life. Touch only on points different from rabbits. More solitary, not social in habits. Said to be more courageous. Sagacity in escaping from hounds and from its many other enemies. When hunted, often stands perfectly still or squats behind a clump of sod, being almost indistinguishable from its surroundings. Often destructive to trees and other vegetation. The article by Cowper, referred to under Helpful Literature, tells much about the life and habits of hares which had been domesticated.

STEP 4. *Summary of whole lesson and expressive work.*

Dwell in this final oral summary on the home and home life of the tame rabbit, and of the hare or American "wild rabbit;" these are nearer to the children, and it is more important that they should know and remember about them. The study of the true wild rabbit of other lands is of value, mainly, as a means of relating, and at the same time distinguishing, these two which occur about our homes.

As much of the matter in this lesson cannot be based on actual seeing by all the members of the class, it does not seem wise to ask all the pupils to write about the home of the rabbit. It may be well to have those who have kept rabbits write about "My Rabbit at Home." These papers may be read and preserved as written summaries. An excellent way of summarizing such a lesson may be to read and discuss with the pupils one or more of the articles suggested under Helpful Literature. The articles will serve to re-enforce and more deeply impress some of the thoughts, which may be more important than the mere facts, and the discussion may enable the teacher to test the real results of the lesson.

Adapting the lesson. Where the children "are full of the subject" of rabbits, tame and wild, it will be necessary to extend this into two lessons. Where they know from observation considerable about the homes of tame rabbits and nothing about their wild cousins, it will be well to emphasize Step 1, and merely touch on Steps 2 and 3. Where they know little or nothing about rabbits, and the lesson is merely so much information given them by the teacher, it should certainly be condensed into one lesson. In such case, however, the reading suggested may occupy another lesson.

LESSON II.

Habits, Positions, and Movements.

Aim. Much as given in Lesson I. We have learned about the homes and home life of the rabbits. To-day we will see how much we have learned, and how much we can learn, with our own eyes, about their habits, and the ways in which their life resembles ours.

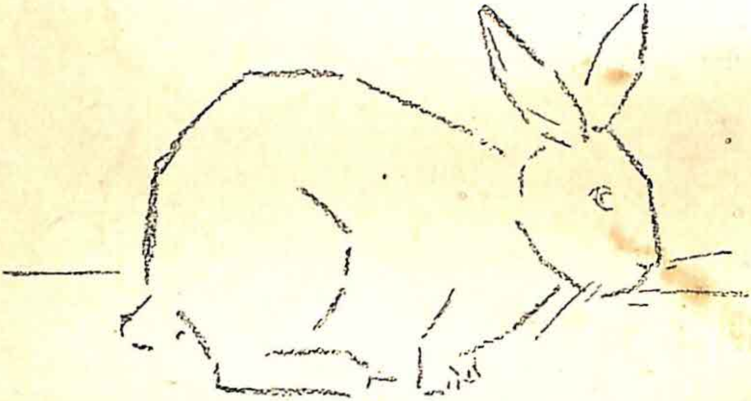


Fig. 16. Drawing of Rabbit, "blocked in."

Preparation. Previous observations. The success of Step 1 will depend almost entirely upon the definiteness of these preliminary observations.

STEP 1. *Positions.*

When at rest. Draws himself together into a furry ball, his back arched, with the highest point back of the middle, his head drawn in close to the body, his ears turned more or less backward, his eyes only partly closed, his feet under him so that they scarcely show.

When asleep. Sometimes in above position. More commonly he stretches his body out full length, turns on one side with his hind legs extended and his head resting on his fore paws, his ears lying back close to the body with the openings always turned outward, and with the eyes always, apparently, partly opened. Rabbits often sleep or rest close together, with their heads on one another.

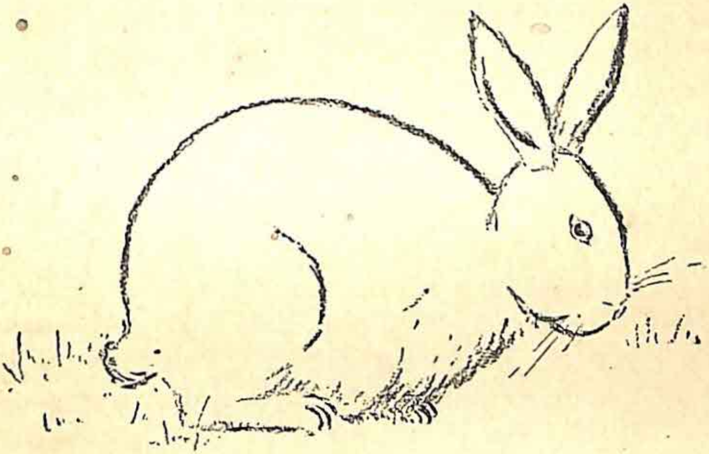


Fig. 17. Drawing of Rabbit, completed.

When sitting. Sits with the hind legs doubled under him and the fore legs straightened, thus raising the fore part of the body, and with the ears erect, or with the body resting on the hind legs and the fore legs quiet or used as hands. When feeding often assumes this position or the next.

When reaching for food or listening. Often stands with body stretched out full length, resting on the hind feet or toes, the head extending upward and forward.

Compare the positions with those of the cat. Notice that their position, whether reclining or sitting, is usually such that they can spring up instantly, that the opening of their ears is always turned outward, that they hear very slight noises even when asleep, and that their eyes never seem to be entirely or tightly closed. Why is this so?

Summary and expressive work. For a summary have at least two children tell, as clearly and exactly as possible, the position of body, head, ears, and feet when the rabbit is reclining, and two others tell about the position of these parts when the rabbit is sitting up, all telling the "why" as far as possible. As the important ideas to be impressed are position or form ideas, and these can be expressed by drawing much more clearly and exactly than by words, drawings may serve as the best summaries. If any pupils can draw fairly well, have them draw, in outline merely, the positions of the rabbit. Have the class, with the rabbits before them for observation, tell the teacher how to draw the outline (only gross features, not details) of the rabbit on the blackboard. If the teacher pretends to know nothing about it, and compels them to observe exactly and express clearly, by drawing only what they tell her and as they tell her (but not carrying this so far as to discourage the children), this exercise may be made very profitable in helping both teacher and pupils to test the exactness of their observations and their power of expressing their ideas clearly.

This Step 1 is essential for giving the children the basic form ideas which will enable them to picture the rabbit, and serves as a foundation for the study of other habits and of structure.

STEP 2. *Locomotion.*

Walking. Watch Bunny in his cage, or where he has little room to move about. Have children recall, or better show, how they walk, moving the two legs alternately, and then how they walk on "all fours." Why do they move the right arm and left leg and the left arm and right leg together? The rabbit walks in the same way, but is apt to bring his two hind feet forward with a jump. Compare with walking of cat or horse or dog. Bunny does not walk much.

Hopping. His usual means of locomotion when not frightened or hurried. Best seen when rabbit is loose in the room. Have the children tell or show how they hop. If they hop on "all fours," they will hop as the rabbit does. The fore feet touch the floor one after the other, then the hind feet are quickly brought forward together.

Jumping. His means of movement when hurried or frightened. Notice how softly and quietly he comes down, and how his feet spread out. Can only be seen when he has room to jump. It is difficult to see just how he does it. How do the children jump? The rabbit does it in much the same way, moves his fore feet forward at the same time, then quickly brings his hind feet forward so that they are outside and in advance of the fore feet, making a jump of a yard or more. A little sand or even chalk-dust scattered on the floor over which the rabbit hops and jumps may show the marks he makes, which the children may often see in the snow.

Adaptation for locomotion. Which legs are the longer and stronger? Why? Why do the hind legs (the portion most readily seen) double backward, like the joint at our ankle, while our legs have the main joint, at the knee, doubled forward? Is there any advantage in this arrangement when the rabbit hops or jumps? Compare with cat, dog, and horse. Why is it easier for the rabbit to hop or jump than to walk? How are his feet and toes arranged and covered to prevent jar and noise when he moves?

Summary. As hopping is the main means of locomotion, so far as the children can usually observe, emphasize this. Have the pupils tell, and if necessary show, or illustrate, exactly how the rabbit hops, and tell what they can about walking and jumping. Have others tell, with the rabbits before them, how the legs, fore and hind, are fitted for hopping and jumping rapidly and noiselessly. Reading and discussing Gibson's *How Bunny Writes His Autograph* will further summarize and impress what they have observed.

STEP 3. *Playing, breathing, burrowing.*

Playing. Nothing probably will so impress on children the similarity between rabbits and themselves, "how akin they are to human things," as watching their frolics. The rabbits the writer observed had great frolics in the schoolroom after most of the pupils had left, playing "leap-frog," "tag," and other games, and acting like two happy, active children.

Breathing. Have the pupils first describe how they themselves breathe, telling about the movements of the chest and sides, and noting how fast they breathe. They can then tell more intelligently what they have observed about the breathing of the rabbit, comparing with themselves. When do the rabbits — and they — breathe most rapidly? Why?

Burrowing. As this is so essential in the life of the wild rabbit and many other animals, it will be helpful if the pupils can see exactly how they burrow, digging with their fore feet, and pushing the earth away with their hind feet. Two or three pupils, preferably those who have rabbits, may be assigned this as a special topic for investigation and report. It is said that rabbits much prefer to make their burrows on hillsides. Why? Many of our hares, or so-called "wild rabbits," burrow under the snow in winter.

STEP 4. *General summary and expressive work.*

Not everything observed or discussed in the lesson can be or should be reviewed at the end, but those habits most important and most clearly observed. If the drawing of the rabbit in one or two most common positions is attempted, as suggested after Step 1, this can be the expressive work. If this seems impossible, perhaps the pupils can write about those things studied in the lesson which they have seen most clearly, and therefore know most about. A good subject will be, "How Our Rabbit Rests and Plays," telling how the rabbit lies when resting, and how he sits, how he hops when playing, and how he breathes after playing. A broader subject with more scope for individual observations is, "What I Have Seen About the Rabbit's Habits." Insist that each pupil tell only what he has seen, and tell it as exactly as possible, looking at the rabbit or going to the rabbit, when necessary, to make sure of the truth of what he writes.

LESSON III.

Habits. Feeding, Washing, and Senses.

Aim and preparation. As in Lesson II.

Material. Living rabbits which have not been fed for several hours. Food, such as cabbage and carrots, to show how they bite off food and how they gnaw. Water for them to drink.

STEP 1. *Feeding.*

Child's eating. Have children tell, and perhaps show, how they eat their food, biting it off with the sharp, flat biting teeth (incisors) in the front of their mouth, and grinding it with the broad, grinding teeth at the back. Have them feel the shape of the two kinds of teeth. They can eat almost any kind of food. Have them note that they move their jaws up and down and sideways when chewing.

Rabbit's food. Leaves, vegetables, bark, etc., not meat or grain, but food which must be bitten off.

Rabbit's eating. Have pupils tell everything already observed about the rabbit's way of eating. Give rabbits cabbage. Note how they often eat together from the same leaf. Note position, commonly reaching up or sitting on hind legs. How does the cleft upper lip aid them? How do they bite off the cabbage? Note carefully number and character (chisel-like sharpness) of front or incisor teeth in each jaw. The rabbit moves his lower jaw up and down and sideways, and from front to back, when he chews, much as the child moves his jaw. It is difficult to see the back or grinding teeth. If necessary, tell children that the rabbits have five or six grinding teeth in each half of each jaw. Compare with food and way of eating of cat or dog. Does the cat or dog have any teeth which rabbit does not have? (Canine or dog teeth.)

Gnawing. Perhaps pupils have already observed the rabbit gnawing the woodwork of his cage or home, or have discovered evidences of his gnawing power. Try to ascertain exactly how they do it, how they use their teeth in the process, and how the teeth are fitted for gnawing. They may gnaw the carrots.

Adaptation. How the rabbit is fitted for its food and way of eating. Reason for the long, chisel-shaped, sharp front teeth. Tell the children that the back of each incisor tooth is softer (composed of dentine) and wears away more rapidly than the front part (covered with enamel); this keeps them always sharp. As fast as they wear away they grow out from the jaw, so that their length usually remains about the same. Sometimes they grow more rapidly than they wear away; then the rabbit has a hard time, and may in time die, because his teeth become so long he cannot eat. Use of the cleft upper lip. Advantage of having the lower jaw move up and down and from side to side and from front to back, somewhat like our jaw, but moving more freely.

Summary.

Have pupils tell: —

How the rabbit's way of eating is like ours, and how different from it.

How the rabbit's teeth and lips are like our teeth and lips, and how they differ from them.

STEP 2. *Drinking.*

How does the child drink? Pours or sucks water into his mouth. How does the cat drink? Curves the tip of its tongue into the shape of a spoon, and laps or draws the liquid into the mouth. How does the rabbit drink?

STEP 3. *Washing.*

How do children wash? Need soap, towel, comb, brush. Do they keep as clean as Bunny? One great reason why he is a pet is because he keeps so clean. How does he do it without soap or towel? How many of the children have their hair well combed or brushed? How does Bunny's fur look? How does he keep it looking so well without comb or brush?

Bunny uses the bottom of his foot, with its stiff hairs, for brush and comb, and his tongue for a wash cloth or sponge. Licks with his tongue parts which can be thus reached; washes face and other parts with paws; holds down ears with hind paw, and washes with tongue or front paw.

This is an interesting step to the children, and will repay careful, patient observation.

Compare with the way in which cat washes herself. Very similar.

STEP. 4. *Hearing, smelling, sight.*

Need of keen senses. To aid in escaping from enemies.

Hearing. Recall how people put their hands behind their ears to help them hear better, and how they turn their hands and ears toward the sound. Some of the pupils may have noticed how horses turn their ears toward the sound.

Note how the rabbits lift up their ears at a sudden sound, and how they are turned with the opening forward and outward. Try to test acuteness of hearing. Note position of ears when Bunny is quiet, resting or sleeping. Reason for having such large ears?

Sight. Eyes seem to be partly open, even when rabbit is sleeping. Why? Our eyes are in front and in sockets. Rabbit's eyes more at sides and are large, "bulging out" more. Why? It is said that the rabbit can see behind and at the side better than straight before him. It must be difficult to close the eyelids over eyes that are so large and protruding. (The belief that rabbits cannot shut their eyes is the basis of the story "Brother Rabbit and the Ginger Cakes" in Joel Chandler Harris's *Daddy Jake.*)

Smelling. Constant motion of nose. Watch nose when cabbage or similar food is brought near. Does the rabbit's sense of smell seem to be good?

Summary. How do Bunny's ears, eyes, and nose help him?

STEP 5. *General summary and expressive work.*

Have pupils write about "How We and the Rabbits Eat, Drink, and Wash Ourselves," letting each tell most about what he is most interested in.

At this time pupils would enjoy and appreciate what Cowper tells about his hares.

LESSON IV.

Literature Related to Life and Habits.

Aim. To broaden and strengthen the ideas of the pupils by having them look at the rabbit and his life through the eyes of others.

Material. Any of the literature or folk-lore suggested under Helpful Literature will be appropriate and helpful. If this is not available, considerable on the habits of rabbits and of their relatives, such as the squirrels, can be found in the books on popular natural history, or in the Nature Readers.

Method. Do not let the class, as a class, read anything with distinct literary merit, such as "Battle Bunny" or anything like the dialect stories of Joel Chandler Harris. They will "murder" it, and miss most of the thought and beauty. Read these to them, or intrust such reading only to pupils who can do it fairly well. That which is merely supplementary reading and not literature may usually be read by the class with advantage.

A little discussed with them and related to their own observations is better than much merely read to them.

It may be well to discuss some of the superstitions connected with rabbits or hares: the carrying of a rabbit's foot in the belief, most prevalent among colored people, that it brings good luck; the fear of a hare or hare's foot among English fishermen, so that the mention of a hare's foot brings terror; a hare thrown into a boat will prevent it from going to sea, and a "hare running along the beach in front of all the fishermen's huts would shut them up as effectually during the day as if each were guarded by a regiment of soldiers;" the old belief that witches could turn themselves into hares.

LESSON V.

General External Structure. Body and Limbs.

Aim of this and succeeding lessons. To lead the child to broader conceptions and greater unity by helping him to see the plan of body of one animal and its adaptation to its life, and to discover this plan and adaptation to life in many related animals.

Aim, as given to pupils: To-day we will find out all that we can about the body and limbs of the rabbit.

Material. Living rabbit, as before. Skeleton, or picture of skeleton, of rabbit or some other quadruped.

STEP 1. *General appearance.*

Review position of rabbit and of legs and ears when he is reclining and when sitting, as studied in Lesson II. The best preparation for the study of structure is to have the teacher make on the blackboard a drawing of the rabbit in these two positions, drawing from the description and directions of the pupils; this exercise will compel the pupils to observe very carefully the form and relative position of the rabbit and of its main parts. After this drawing has been made and erased, if the pupils can draw the rabbit for themselves; drawing as exactly as they can, directly from the rabbit, the study and description of form or general external structure will be much simplified.

STEP 2. *Body, trunk, head.*

Body as whole. Form egg-shaped, or somewhat cylindrical when stretched out. Narrower and somewhat pointed at anterior end, like most boats and fishes.

Position commonly along or parallel with ground. Compare with usual position of children.

Compare size with that of other familiar animals, such as cat. Measure absolute length and height, and relative length of trunk and head.

Furry covering. Everywhere except on inside of ears and tip of nose. Beauty; softness and fineness (have pupils feel it) and color. Note color under feet. Variations in color in different individuals. Color becoming lighter in winter in hares. Use; to beautify and to protect from cold. Compare with clothing of children and furs worn in winter.

Two main divisions. Form and relative size, and relative position of trunk and head. Impress by sketching mere outline of the two. Each generally ovoidal. Head about one-third length of trunk, with its longer axis oblique (about 60°) to axis of trunk.

STEP 3. *Tail and limbs.*

Tail. Position, direction, size, covering. Impress small size by contrasting with other animals.

Limbs. Review what was learned in Lesson II. about usual means of locomotion, hopping and jumping. How many times as far can the rabbit jump as the child, keeping in mind their relative size.

Have children tell about their own legs and arms, their position, relative size, the direction of motion and comparative freedom of motion of arms and legs, the three divisions of each (upper arm, fore arm, and hand, and thigh, leg, and foot), and the direction of motion at the joints, at knee, ankle, elbow, and wrist. Have them note and show how, when ready to jump, they stand on their toes, with legs flexed at ankle and knee, and spring by suddenly straightening these joints.

Position and attachment and covering of legs of rabbit. Greater freedom and range of motion of fore legs. Greater size and strength of hind legs.

Parts of hind leg. Thigh, leg, and foot. Compare with child's leg. Thigh very short, with joint corresponding to child's knee close to the rabbit's body. Leg, corresponding to part of child's leg between knee and ankle, long and strong. Prominence of ankle joint. Part below the ankle joint, corresponding to child's ankle and foot, greatly lengthened. Cushion or pad near end of foot covered with brush-like hairs. How many toes on each hind foot? Are they movable? Do they spread out? Compare legs, toes, and claws with those of cat or dog.

Fore limbs. Relative size of parts and character of joints, as compared with similiar divisions of child's fore limbs. Number of toes and flexibility. Comparison of fore paws with child's hand.

Adaptation or "why." Use of limbs. Hind legs mainly for jumping or hopping, the rabbit's way of moving about. Fore legs mainly for grasping things, and sometimes for defence. Compare with uses of child's legs and arms. The former require strength, the latter freedom and range of motion. Legs adapted for jumping by their strength and character of joints and direction of bending. The lengthened foot gives a firmer support, and probably greater strength and quickness. The flexibility of the foot and toes, and cushion on the toes, lessen the jar and noise when alighting. The spreading of the toes and the hairy brush aid in making the step so noiseless, and assist in walking on the snow. In similar way study adaptation of fore leg.

Do not let this degenerate into a mere "guessing match." Base all study of adaptation on definite, careful observation of habits, structure, and use; otherwise it is useless, or worse than useless.

In this study of adaptation, teacher and children are "thinking God's thoughts after Him" in a way which appeals very strongly to children, if it is properly done, based on what has come to them through their senses, not merely "preached" to them.

STEP 4. *Skeleton.*

Have children discover, by feeling their own bodies, that each has a backbone, ribs, and a bony framework or skeleton, in arms and hands and legs and feet. Lead them to think and tell about some building which they have seen in process of erection. What is the use of the framework of the house? Of the skeleton or bones of the body?

Holding Bunny by the ears, have one or two children gently feel of his body. Does he have bones? A backbone? Ribs? Bones supporting hind legs and feet? Bones in fore leg and feet? What are they for?

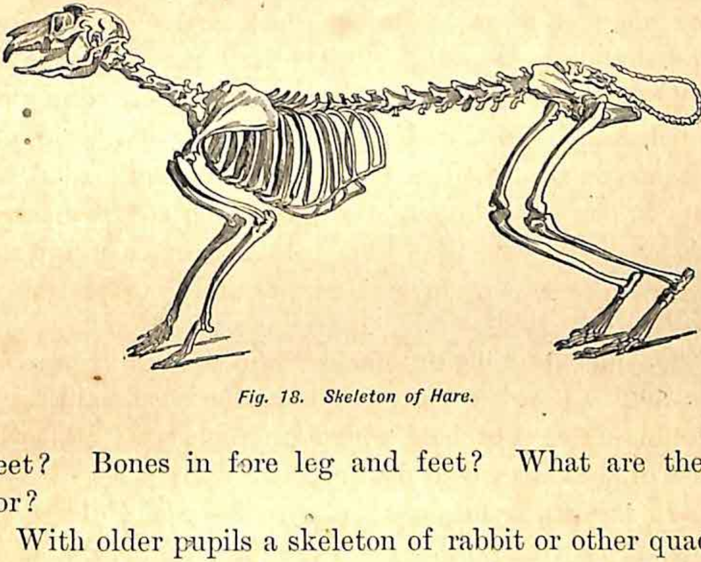


Fig. 18. Skeleton of Hare.

With older pupils a skeleton of rabbit or other quadruped, or picture of a skeleton, will be helpful in impressing the plan of the bony framework. Compare with picture of human skeleton.

With young children touch very lightly on this step.

STEP 5. *General summary and expressive work.*

A drawing of the rabbit, drawn with care by each child from nature, even though very crude, is the best way of reviewing, making clear and exact, clinching and expressing, the main points of structure.

If this seems too difficult, have them write about "What I Have Learned About the Rabbit's Body and Legs," or "The Parts of the Rabbit's Body and Legs, and How They are Fitted for His Life," or "Ways in Which the Rabbit's Body and Legs and My Body and Legs are Alike." The written work may be left until after the next lesson, which is short.

Adapting Lesson. If too long, dwell on structure and adaptation of limbs, and on existence of backbone and of bones in limbs.

LESSON VI.

General External Structure. Head, Ears, Teeth.

Aim. As in Lesson V.

Material. Living rabbit and cat or dog. If obtainable, skeleton, or picture of skeleton, of head of rabbit and of cat or dog, showing kinds, arrangement, and number of teeth.

STEP 1. *Drawing.*

A drawing, made as carefully as possible by each pupil from nature, of head and neck, bringing out relative position and form or appearance of neck, head, ears, eyes, nose, and whiskers, will compel the pupils to observe much more carefully than if they merely tell or write about them, and will greatly aid in impressing these features upon the mind.

STEP 2. *Head as whole.*

Connected with body by short, flexible neck. Neck often looks as if string were tied about body where head joins it. Head somewhat egg-shaped, its axis oblique to axis of trunk, and about one-third as long, covered with fur, except inside of ears and tip of nose.

STEP 3. *Ears, eyes, nose, and "whiskers."*

Ears. Position: on top of head. Compare with position and freedom and range of movement of child's ears. Form: like a leaf rolled at base. May be well to have a piece of paper cut shape of ear and rolled in same way. Size: measure length, and compare with length of head. Covered with fur on outside, with hairs inside, longer and more numerous toward base. Network of veins on inside, giving pinkish tinge. More or less transparent, and apparently delicate, but quite strong, as shown by fact that rabbits are carried by their ears.

Eyes. Have pupils observe and tell about their own eyes, — their position in front of head, sunk in sockets, with upper and lower eyelids, with eyebrows and eyelashes, with a dark pupil in centre of eyeball, a colored part or iris about that, and the white of the eye around the iris.

Compare rabbit's eye with child's eye. Is on side of head, large, stands out from head, is usually pinkish, has parts corresponding to parts of child's eye, but somewhat difficult to see. Perhaps quick-eyed pupils can discover under the two eyelids a thin, membraneous "third eyelid," which covers the pupil somewhat when the eyelids are brought together, and is drawn down into the inner lower corner of the eye as the eye is opened. If they watch the movements of the eyes, they may observe that the rabbit can turn his eyeball toward his tail, and see behind him with little movement of the head.

Nose. Position: very freely movable, and almost constantly in motion. Small, as compared with most animals. Naked at tip (compare with cat or dog), with V-shaped partition between two openings, or nostrils.

"*Whiskers.*" Position: at side of mouth and below eyes. Compare with cat's "whiskers." Are said to aid rabbit in feeling, and to tell him whether any opening his head may enter is large enough for his body to pass through.

Adaptation. Advantage of position, form, size, and freedom of movement of ears; use of hairs on inside. Advantage of having eyes on side of head; of having them stand out so far from head; use of "third eyelid" if rabbit does not shut his eyes.

Summary. With topics below written on blackboard, have pupils tell orally, with as few questions as possible, all they can about—

The head: position with reference to body, shape, size.

The ears: position, movements, shape, size, how adapted to rabbit's use.

The eyes: position, parts as compared with pupils' eye, how adapted to needs of rabbit.

The nose: position, movements, size, covering, openings.

STEP 4. *Mouth and teeth.*

Mouth and lips. Position of mouth. Upper lip cleft up to nose. Why? Recall what pupils have observed about advantage of this when gnawing. Lower lip small.

Jaws. Have pupils note that we can move only our lower jaw, not our upper jaw, and can move it up and down, from side to side, and slightly, from front to back.

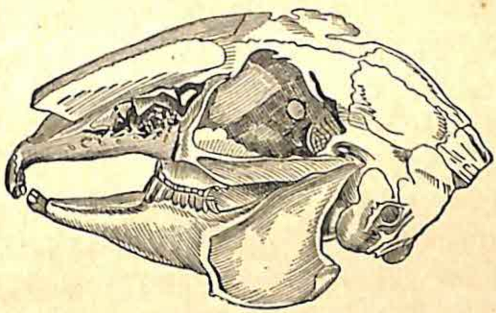


Fig. 19. Skull of Rabbit.

The up-and-down movement enables us to bite. How do the other movements aid us in grinding our food? Movements of rabbit's lower jaw are similar; but the movement from front to back, best seen when he is "chewing his cud," is greater.

Teeth. Have pupils ascertain and tell about the kinds of teeth in their own mouths: the chisel-shaped biting or incisor teeth in front of each jaw; the longer, pointed teeth next to these, the dog teeth or canine teeth, one on each side of the incisors; several flat, rough grinding teeth, toward the end or side of the jaws. Use made by children of incisors and grinding teeth.

Examine teeth of cat or dog. Incisor teeth readily seen, but grinding teeth somewhat difficult to see. Great length of canine or dog teeth. Used and fitted for seizing and tearing animals and meat.

Examine teeth of rabbit, comparing with teeth of child, and of cat or dog. Back teeth will probably have to be studied from a skeleton, or picture of skeleton of head, or the teacher may have to tell pupils about them. Note the two long sharp incisor teeth in the front of each jaw, and the space at either side of these without any teeth. From a skeleton of the rabbit's head can be seen the two additional very small teeth back of and hidden by the incisors in the upper jaw (found only in rabbits and hares), and the five or six flat grooved grinding teeth in the ends of the jaws, each with a transverse ridge of enamel, so that it appears to be composed of two halves.

The provision made for keeping the incisor teeth sharp, and for replacing the parts worn away by gnawing, has been already given in Lesson III.

The character and number of the teeth are very important in classification; hence pains should be taken to have them thoroughly understood as a basis for the next lesson on classification.

Adaptation. See also Lesson III. The rabbit belongs to a group or order of animals called "gnawers." How is it adapted for gnawing? By cleft upper lip, free movement of lower jaw, and position, shape, size strength, arrangement of enamel, and manner of growth of teeth.

STEP 5. *General summary and expressive work.*

Making a drawing of head and parts externally visible is most exact and effective way of summarizing these. With this, or in place of it, can be an oral or written summary, telling briefly but exactly "How the Rabbit's Mouth and Teeth are Fitted for His Food."

LESSON VII.

Comparison and Classification. "Gnawers" or Rodents.

Aim. To broaden pupils' conceptions and lead to greater unity in their minds; to train them to compare, to discriminate between essentials and non-essentials, to understand plan and to discover similarity of plan amid great diversity in minor details; to make rabbit a type in the pupils' mind of a great order of animals, the "gnawers" or rodents.

Material. Living rabbit and cat or dog; hare (can often be obtained from meat market in winter), or picture of hare, showing incisor teeth; any other rodents, living, dead, or mounted, such as rat, mouse, squirrel (in winter can sometimes be obtained at market), gopher, prairie dog, or woodchuck; pictures of beavers, and of any carnivorous animals, showing canine teeth.

Essentials of classification. Classification is based on essential similarities, or similarity in plan, as distinguished from such minor characteristics as size, color, and markings; two houses may be very similar in plan, and yet differ greatly in size, color, and markings, or trimmings or decorations. Hence it is wise to begin the comparison with two quite similar animals, to dwell on essential similarities rather than differences, and to emphasize these similarities, bring them into stronger relief, by contrasting these similar animals with those quite dissimilar.[1]

Comparison and classification require very careful questioning or development work by the teacher. Distinguishing between essentials and non-essentials requires knowledge and judgment; abstracting and applying plan demands some intellectual power. Hence in this work the pupils need considerable guidance and help.

---

[1] The most essential features in the classification of the rabbit are: —

The bony skeleton and backbone or vertebral column, placing it among the vertebrates.

The hairy covering or fur, placing it among the class of vertebrates called mammals.

The way in which it feeds and the character of the teeth, two large incisors, and the molars in each jaw, with no canine teeth, showing that it belongs with the order of mammals called "gnawers" or rodents.

The long ears, short tail, and two small accessory incisor teeth, hidden behind the large incisors of the upper jaw; these are characteristic of the family of hares (the leporidæ), including the rabbits.

The ears, shorter than the head, and the habit of burrowing in the ground, distinguish the rabbit from the hare.

These essential features are given here merely to assist the teacher and give point to the lessons which follow. They should be gained from the children, as a result of their observations and comparison, never merely given to the pupils.

STEP 1. *Comparison of different rabbits.*

Have pupils compare size, color, and markings of the rabbits they have with others they have seen, to show that they may differ in these respects and still be rabbits; that is, that size, color, and markings may not be important in classification. If they cannot compare many rabbits, compare the cats they have seen, to impress the same thought.

STEP 2. *Comparison of rabbit and hare.*

Have pupils compare with hare or picture of hare, bringing out similarity in general appearance and plan, in possession of backbone, in being covered with fur, in having teeth alike in number and character, and differences in length and color (?) of ears, and habit of burrowing in the ground. The pupils will tell of other points, but teacher should emphasize and clinch those above.

If slight comparison is made between the rabbit and hare and the cat, the essential similarities will be impressed by contrast.

STEP 3. *Comparison of rabbit and other rodents.*

Have pupils compare rabbit with squirrel, chipmunk rat, mouse (small for most satisfactory work), muskrat, woodchuck, gopher, beaver, or other available gnawing animals, bringing out similarities in general plan, bony skeleton, possession of fur, and character of teeth, and the essential differences: such as the climbing habits, short ears, long, bushy tail, sharp claws, and greater comparative length of upper incisors in the squirrels; the burrowing habits, thick, clumsy body and short legs of the woodchuck; the similar habits and body and cheek-pouches of the prairie dog and gopher; the aquatic habits, webbed hind feet, and broad, flattened, scaly tail of the beaver; the aquatic and burrowing habits, long tail, musky odor, and color (brownish above, gray beneath) of the muskrat; and the omnivorous habits, long, naked (not covered with hair) tail, and narrow, pointed, lower incisor teeth of the rats and mice. Try to relate differences in structure to differences in habits.

The results will be much more satisfactory if the rabbits can be compared with two or more other rodents; it is dangerous and wrong to encourage or allow the pupils to generalize from too few particulars, as they do when they assume the characteristics of rodents from the observation of two species.

STEP 4. *General summary.*

Gather up from the children, characteristics in which all studied (except the cat) are similar; general plan, backbone, fur, teeth. In what respects are all like the cat? In what respects do all differ from cat?

Write on the blackboard a list of points in which all the animals studied are like one another and unlike the cat. All animals having these characteristics are called "gnawers" or rodents. Write under this, gaining from pupils, *distinctive* characteristics of the different kinds of rodents studied. This tabular view appeals to the eye and greatly helps the memory. Have children make copy of it.

LESSON VIII.

Comparison, and Classification. Verterbrates and Mammals.

STEP 1. *Comparison of rabbit and cat.*

Review points in which all animals previously studied (except cat) are alike, points in which they are like the cat, points in which all differ from the cat. Cat differs in having a longer, more lithe body, incisor teeth more numerous, and not well fitted for gnawing, canine teeth long, conical, and pointed, grinding teeth with two or more rather sharp projections on their outer end, not well fitted for grinding, and claws strong and sharp. Relate differences in structure to differences in habits and food, to bring out the "why."

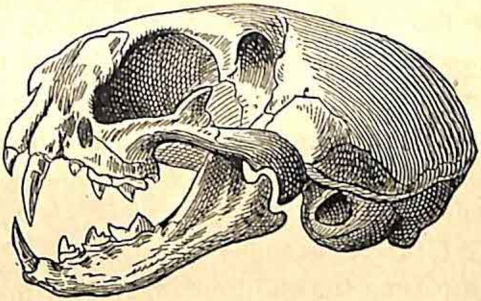


Fig. 20. Skull of Cat.

Compare cat with dog. Similar, but claws not so sharp. Why cannot dogs climb trees?

Compare rabbit and cat with any other carnivorous animals of which mounted specimens or good pictures, showing canine teeth, can be obtained. Relate peculiarities of structure to habits.

Gather from pupils, and write on the blackboard, a table such as the following:

Gnawing Animals or Rodents —	*Flesh-Eating or Carnivorous Animals —*
Have four long chisel-shaped incisor teeth.	Have many (twelve) small incisor teeth.
Have no canine teeth.	Have four long pointed canine teeth.
Have flat-topped grinding teeth.	Have grinding teeth with tops having points.
Gnaw and grind their food.	Tear and grind their food.
Rabbit, hare, rat, mouse, squirrel, woodchuck.	Cat, dog, fox, wolf, lion, tiger, skunk, wildcat, leopard, bear.

All have a bony skeleton and backbone, and are covered with fur.

STEP 2. *Comparison of rabbit with chicken and fish.*

These are selected because most children have discovered, when eating them, that they have a bony skeleton and backbone.

Chicken. Like rabbit in having bony skeleton and backbone. Different from rabbit and all the other animals studied in having two legs, a pair of wings, a hard mouth or bill, and in being covered with feathers.

Fish. Like rabbit in having bony skeleton and backbone. Differs from all animals already studied in having no legs, swimming in the water with its fins and tail, and in having its body covered with scales (generally) instead of fur or feathers.

All animals studied so far have skeleton and backbone.

STEP 3. *Comparison of rabbit and some invertebrate animal.*

Select any invertebrate animal which pupils have discovered, or can be led to discover, to be without internal skeleton; that is, without backbone or bones of any kind, such as the caterpillar, slug or shell-less snail, earthworm, or some insect.

How like other animals studied? Only in having life, and in being an animal instead of a plant, in having power to move itself, and a mouth to take in food. Differs from most in having no backbone or bones, and in having more than four legs.

All those with a backbone are called vertebrates. The others are invertebrates.

All vertebrates with more or less furry or hairy covering are called mammals. All with feathery covering and wings are birds; all with scaly covering (sometimes naked) and with fins are fishes.

STEP 4. *Summary and expressive work.*

Have pupils review both process and facts by having them write (assign different topics to different pupils) about: —

1. "What we learned from the comparison of different rabbits."
2. From the comparison of rabbit and hare.
3. Rabbit and squirrel.

4. Rabbit and cat.
5. Rabbit, chicken, and fish.
6. Rabbit and caterpillar.

Written summaries are usually more definite and exact. Have these read and discussed in class.

Pupils can apply what they have learned about classification by writing the following lists of animals: —

1. A list of all the animals they can think of which are vertebrates.

2. A list of all the animals they can think of which are not vertebrates or are invertebrates.

3. A list of vertebrates which are also mammals.

4. A list of mammals which are also carnivorous animals.

5. A list of mammals which are also gnawers or rodents.

Why is our rabbit classed with the vertebrates? With the class mammals? With the order rodents? With the family of hares?

ADAPTING WORK TO OTHER GRADES.

For Grades or Years One and Two.

The work as planned will certainly occupy two weeks, forty-five minutes to an hour a day. Little folks could not do much of the work outlined; it would be difficult to keep them thoroughly interested in one topic so long. They are most dependent on their senses, must have work most closely related to their child-life, and have very little power of reasoning or of abstracting.

With the children of the first or second year there should not be more than five lessons on the rabbit. After having the rabbit in the room a week, to get acquainted and answer the simpler questions given under Preparatory Work, the lessons could be divided as follows: —

LESSON I. Home and Home Life of Child and Tame Rabbit.

LESSON II. Habits. Movements and Playing of Child and Rabbit.

LESSON III. Habits. Food, Feeding, Washing, Hearing of Child and Rabbit.

LESSON IV. Structure and Adaptation. Limbs, Teeth, Ears of Child and Rabbit.

LESSON V. Bunny's Cousins. Squirrels, Rats, Mice.

For Grades or Years Three and Four.

LESSON I. Something of life of our own "wild rabbit" or hare, in addition to life of tame rabbit, dwelling on difference in life, rather than on differences in structure.

LESSON II. Careful study of one or two most common positions, of walking, hopping, and playing, and of breathing.

LESSON III. Much as given.

LESSON IV. Much as given.

LESSON V. Somewhat less detail.

LESSON VI. Dwell on ears, jaw, and incisors, and on adaptation.

LESSON VII. Compare rabbit with two other rodents, with cat and with fish and chicken (or canary-bird), dwelling on clearly visible characteristics (the bony skeleton is not visible), and trying to impress clear idea of gnawing animals and of hairy or fur-covered animals.

For Upper Grades.

In grades five or six, for which this is planned, and with older pupils, the study of the rabbit may well be a veritable "introduction to animal study." Beginning with the rabbit, the other rodents or mammals or vertebrates may well occupy for months the period which can be given to nature study. In the school with which the writer is connected such work, continued four or five months, three to five times a week, has aroused great interest and given very satisfactory results in grades six, seven, and eight. The boys in particular, at this age, are apt to take more interest in such animal study than in plant study. The work must, however, be observational, based on the careful observation of type animals, not mere reading and talking about animals.

CHAPTER III.

WHAT IS NATURE STUDY?

For many years a struggle has been going on in our higher institutions of learning between the upholders of the classics and of the sciences. One class has limited education almost entirely to the study of man and his languages, history, and literature, and to methods of exact reasoning, or mathematics. The other has advocated the study of man's surroundings, his physical environment, of the world in which man is placed and on which he so largely depends. The defenders of the classical education have been compelled to yield point after point to the champions of the scientific education. To-day we are coming to the conclusion that we can get the best well-rounded, liberal education by a compromise between the two opposing schools, in the study of man and nature.

From the higher seats of learning the struggle has passed into the secondary schools, the high schools and academies, where a similar compromise is being effected, or a sharp distinction made between the students taking classical and those pursuing scientific courses.

Our elementary schools have until recently confined their work to the human studies, or studies relating to man, to his language and other methods of conveying ideas, to his methods of exact reasoning, and to the way in which he has parcelled up the earth. Everything has been centred about man, as the universe was once supposed to be centred about the earth. Even geography, the study of which might well have brought the pupils into closest relation with their physical environment, has been, not a study of the earth, of our physical environment, but almost entirely a study of a description of the earth, and of a description, not to any great extent of physical forces, processes, and features, but very largely of the divisions made by man, and of the features due to man. The schools have placed all emphasis on the "essentials," reading, writing, and drawing, arithmetic and geography. The children in these schools have studied almost nothing of the other part of their environment, the physical world, which forms such a large part of their life.

To-day the old conflict is being waged in these elementary schools. The champions of science are urging the introduction from the beginning of the child's school-life of some study of the world of sense which lies about the child. This has been designated as elementary science, or nature study.

It seems wise at the very beginning to determine just what we mean by elementary science, or nature study. This will prevent ambiguity and misunderstanding in later discussions.

The terms "elementary science" and "nature study" are both widely used. Elementary science is, perhaps, more exact, and therefore more scientific. Nature study has a less formidable sound, and better expresses the spirit in which the work should be undertaken. It seems much the better term, at least for the work in the first four or five years of the school course.

The former term includes two ideas. First, it is elementary, as distinguished from advanced. In the aim or purpose of the work, in the material selected, in the methods pursued, it is elementary; planned for and adapted to the needs and capacities of the pupils of elementary schools. In the second place, it is science, classified knowledge.

"Knowledge" our dictionary defines as "clear and certain perception," "familiarity gained by actual experience." In the very beginning we cannot emphasize too strongly the ideas involved in these definitions of knowledge, — "clear and certain perception," "familiarity gained by actual experience." Let us analyze them. "Clear," — not hazy or foggy, but sharp and distinct; "certain," — not what we imagine or think we know, but what we are absolutely sure of; "perception," — not what has come to us from others alone, from book or teacher, but the mental picture based upon what *we* have *seen*, or what we have apprehended with our own senses. Equally significant is the other definition. "Familiarity," — "intimate and frequent converse or association," like that among the members of a family; "gained," — acquired by effort, not merely absorbed; "actual," — real, as distinguished from theoretical; "experience," — "practical acquaintance by personal observation," "continued and varied observation," "personal trial and experiment."

How much of the stock of information possessed by the pupils in our schools will stand the test of these definitions of knowledge? How much is "clear and certain perception"? How much is "familiarity gained by actual experience"?

In the third place, elementary science is knowledge classified or studied in its relations, arranged and grouped by the children. Isolated facts of observation may be knowledge, they may be "clear and certain perceptions," but they are not science, they are not classified. Until these facts are related and grouped they are of comparatively little value to the mind. Unless they are tied up in assorted bundles, the mind that possesses them may be little more than a mental junk-shop. When they are properly related and grouped, each perception suggests a host of related ideas, each fact or group of facts becomes typical of the great class to which it belongs.

Later we will discuss the various relations in which our physical environment can be considered.

To recapitulate, elementary science is: —

1st. *Elementary*, adapted in aim, plan, methods, and materials to the capacities and needs of the children in the elementary schools.

2d. *Knowledge*, "clear and certain perception," "familiarity gained by actual experience."

3d. *Classified*, considered in its relations, and arranged and grouped (by the child, not merely by teacher or book) in accordance with the relations and the differences and similarities the child has discovered.

If this definition is correct, we can test the work being done under the name of elementary science by seeing how far it meets the requirements of the definition. Is it "elementary knowledge classified"?

We shall find in our schools and homes, or clamoring for admission, three general classes or kinds of science work, or so-called science, which do not meet these conditions.

Our university or college or high-school friend, interested in education, enthusiastic in his specialty, would have us introduce, or has already introduced, into our schools such work as he carries on with his students, with very little modification or adaptation to children. The botanist would have our little folks begin with the plant cell as the unit of plant life and structure, or with the lower forms of plants, such as pond scum, and work up step by step to the complex organism which the child calls a bean plant. This seems to the botanist the simplest, easiest, and only logical method of procedure. The mineralogist would have the children begin with the chemical elements of which minerals are composed, and build up the minerals and rocks, because to him a mineral means nothing unless he knows its components. Both overlook the fact that what is logical and simple for them may be illogical and incomprehensible to the child, and what is complex for them may be simple to the child. Both forget the long process of education, much of it unconscious, by which they learned to analyze the common things about them, before they could even understand that they were complex, much less resolve them into their components, or build them by a synthetic process from their components. The teachers of college and high-school students, discouraged by their lack of power to do careful work, and appreciating the need of a better training in exact, thorough scientific methods of study, may do, as did the writer, insist on the most careful, exact, detailed work, even in the primary grades, either not realizing, or forgetting, that the children's minds and hands and eyes are not fitted by nature for such work. This is science, but it is not elementary; it is not adapted in material and methods to the nature and needs of the children.

Other friends of our schools would place in the hands of our children beautiful and interesting books telling all about the wonders of the world about them. They would introduce into the homes and schools Nature Primers and Nature Readers, and Stories Mother Nature Told Her Children, from which the pupils can imbibe or absorb some of the facts, or what are supposed to be facts, concerning the world in which they live. These books may be good, they may be helpful, they may be elementary, well adapted to children; but this is not science, it is not even knowledge. It is not "clear and certain perception;" it is not "familiarity gained by actual experience."

A third class, with a better appreciation of the needs and capacities of the children, with a better understanding of the conditions of our schools, would have the children go to nature instead of the book, watch the swelling bud, the developing seed, the opening flower, note the flight and song of the bird, and peep into its nest, glance at the fly or grasshopper, admire the brilliant coloring of the butterfly. They would have our children, butterfly-like, sip a little here, a little there, taste in this place, in that place. This is better, very much better; where the child is surrounded by nature, almost immersed in nature, it may be an excellent means of arousing in him the interest and sympathy and spirit which are the first essentials in his best development. It may lead to knowledge, to fairly "clear and certain perception." It may lay the foundations for science; it is on just such foundations that all science has arisen.

But if it stops with sipping and tasting, if the knowledge is simply taken in and not digested or assimilated, if it is not expressed in a form intelligible to others, it is only the beginning of science. Unless the phenomena are observed or studied in some order or sequence, unless their study prepares for and leads to a careful investigation of the relations of the various phenomena observed, unless it results in comparison, in some natural classification by the child, and, finally, in broader and broader generalizations and a better comprehension of the unity of nature, it is not science. The method, if it may be called a method, so prevalent in many of our schools, of studying without plan or sequence anything in nature which may be accessible or convenient, to-day a plant, to-morrow a bird, next day a stone, or the wind or weather, may interest the children, may develop and train the teachers, may be a preparation for elementary science; but it is not elementary science, it is not or does not result in "knowledge classified."

To get the best results in elementary science in our schools, we need a clear, definite plan or course of study, with its various parts closely related. The work of each grade should be adapted to the children of that grade, based on the work of the preceding grade, and should prepare for the next grade above. Then our work will become, in truth, elementary science.

The term "elementary science" refers mainly to the results of the work, classified knowledge. The term "nature study" has more reference to the materials considered and the methods pursued, and better expresses the spirit in which the work should be carried on. The materials are found in nature, our physical environment. The methods are the methods of nature, those by which we have always become acquainted with our surroundings since we first opened our eyes on this world of sense. The spirit in which we should study nature, the spirit in which children approach a constant companion or friend, is better indicated, to the children and teachers at least, by the simple "nature study," than by the somewhat high-sounding and formidable "elementary science."

Nature study is first *nature* study, a study of our physical environment. It is not a study of books. Books may help, may tell us about nature, but they are not nature. It is not listening to the teacher as she tells about nature, or what purports to be nature. It is not merely gazing with awed attention at the interested, observant, bright boy of the class, as he tells what he has read, or even seen. This may be studying about nature; but it is not studying nature, it is not nature study.

Nature study is not merely a study of nature, but of nature under natural conditions, so far as this is possible. It is not merely schoolroom study. Nature belongs out-of-doors, and out-of-doors we must go to study many of her manifestations. Field lessons are a necessity for the best work. Nature constitutes much of the child's out-of-school environment. He is learning from nature, consciously or unconsciously, almost continually. Much of what he thus learns out of school-hours in nature's school must be utilized in his nature study in school. When we confine nature study to the schoolroom and school-hours, we shut out the best part of nature.

The word science is apt to be associated in our mind with a laboratory, and an array of instruments and appliances. The laboratory for nature study is all out-doors; and the only instruments and appliances absolutely necessary are the seeing eye, the hearing ear, and the understanding heart.

Nature, real nature, is instinct with life and action:

is living and developing and doing. The science in our educational institutions has been heretofore, very largely, a study of form and structure and plan. But nature is not mere form or structure.

We must study the life and life history of animals and plants, and the work performed by their various parts or organs, as well as their form and structure; the changes through which our rocks are passing or have passed, as well as their structure and components; the forces which are now affecting the earth, and the processes which have brought the earth to its present condition, as well as the present forms and features of the earth. Otherwise we study only a part of nature, and that side of it which is least adapted to our elementary schools, and of least value to our pupils.

Nature study is, in the second place, nature *study*. As has already been shown, it is not merely talking or reading about nature; it is not merely glancing at the beauties or sipping the sweets of nature. It is definite, orderly, systematic *study* of nature by each pupil and by the teacher.

Nature study is, furthermore, nature studied in its relations. Every phenomenon in nature stands in relation to a host of other phenomena. The dandelion in our hand is related to the whole plant, and to each part of the plant — a relation of mutual dependence and helpfulness. It is related to, and dependent upon, soil and rain and sunlight and wind. It is related to the insects which feed upon or fertilize it. It has a relation, of similarity or difference, to a host of other flowers. It contributes to the happiness or comfort of man, and has inspired the poet. It points up to its Maker and Protector. It has many other relations. To understand nature, we must keep in mind, investigate and arrange or group, these relations whose mutual actions and reactions constitute nature. These relations can be summed up as follows:—

First. To the whole of which it is a part, and to other parts of that whole. The flower or leaf is not merely a flower or leaf, but is related to the whole plant, and to every part of the plant. This brings out function, or use, and plan.

Second. To natural environment. The plant or animal is related to water and soil and food and air. This brings out life and function, and adaptation of structure to function or work, and impresses mutual dependence and co-operation.

Third. To past and future. The study of plant and animal is incomplete until we investigate its life history. The raindrop is but one stage in a long series of changes or transformations. The fragment of rock or of soil is most wonderful and instructive when considered as a history of the past, or a prophecy of the future.

Fourth. To other individuals, similar and dissimilar, leading to comparison and classification.

Fifth. To other phenomena, bearing to it the relations of cause and effect. These relations are prominent in physics and chemistry.

Sixth. To man, ministering to his spiritual, ethical, æsthetic, and material nature and needs. Nature must be studied in its relations to man's higher nature, leading to the best in literature and art, and in its utilitarian or practical relations.

Seventh. To the Creator. Nature reveals a Protector and Planner, and points to a purpose and first cause. Nature study misses its highest object and greatest value unless it leads to that which is above nature.

Eighth. To the school and to school-work: as a means of interesting and stimulating children; as a basis for expressive studies, — writing, reading, drawing, modelling, painting, arithmetic; as a preparation for and aid in geography and literature.

If the children study nature it must be from their standpoint, not from the standpoint of the mature mind. Those phases of nature must be studied which are nearest to the child and most strongly appeal to him. This is discussed more fully in later chapters.

It must be not merely a study of nature by the children, but a study of nature by the teacher with the children. In this work the teacher who depends on books in her preparation will have pupils who depend on their teacher. The teacher who studies nature with her children — fellow-investigators of truth — will inspire and be inspired by her pupils.

To sum up our definition of nature study, it is: —

NATURE — not books, not mere reading or listening; nature under natural conditions; nature living and in action, not mere form and structure.

STUDIED — not glanced at or sipped, or talked about or read about, but studied, — a personal investigation.

In Its Relations — to all the universe, — nature, man, and God.

By the Child — by each child individually, not merely by the teacher, or by bright or interested children.

From the Child's Standpoint — not merely from the standpoint of the mature mind.

By the Teacher — not merely by the children.

With the Children — teachers and children fellow-investigators of truth.

It may seem that we have given undue prominence, and placed unnecessary emphasis, on definitions; but experience has shown this to be necessary. No matter how earnest the spirit of the teachers, and however honest their intention, the habits and training of a lifetime, which have too often made books crutches instead of helps, will assert themselves. Teachers will study, under the guise of nature study, anything and everything but nature. They will deliberately shut their eyes to nature, and confine their investigations within the covers of a book. They will cram their pupils' minds full of memorized facts and names and classification, and call that nature study.

CHAPTER IV.

THE AIM OF NATURE STUDY: TO DEVELOP THE INDIVIDUAL CHILD.

THE question is asked by many, "Why introduce nature study into our schools?" We might better ask, "Why stop nature study when the child enters our schools?" In the early life of the child, the world of nature is his world. With this world his senses bring him into closest relations. His earliest education is almost entirely in nature study, and by nature's methods, — an education of seeing and doing, of using his powers and developing them by using. Is there any reason why this should stop when he enters school? Is there any more natural way, any better way, of developing his powers than to follow the leadings of nature, help and train him to see and do more, and then to think and tell about what he has seen and done? Is there any knowledge which is more essential to him than a knowledge of his surroundings?

The burden of proof is on those who would stop nature study when the child enters school.

Before it is possible to discuss intelligently methods of work, it is necessary to consider somewhat carefully the aim or purpose of the work. The methods of work will depend very largely on the aim or purpose. Consciously or unconsciously every teacher will be influenced in her methods more by the final aim she keeps in view than by any other one factor.

This has been illustrated in the introductory chapters. If our aim is to study and describe the form of the dandelion, or if, back of this immediate aim, we think only of training our pupils to see and describe, we shall be satisfied with a mere pulling to pieces of the parts of the plant, and a description or drawing of what is observed. If we want our pupils to make the dandelion a type, or wish to train them to discriminate and compare and classify, we shall have them compare the structure of the dandelion with that of other plants. If we feel that our boys and girls should understand something of the life of the dandelion, should, through its study, be brought into more sympathetic, loving relations with nature, should better appreciate the beauty and symbolism of nature, should, through their dandelion study or nature study, have the higher side of their nature cultivated and developed, then we shall emphasize life and function and adaptation, and select from literature all the beautiful thoughts that we can find. Our aim will determine our method.

Method is simply the determination of aim, and the application of aim to conditions in accordance with the laws of the child mind. Teachers who so thoroughly appreciate the aims, and particularly the highest aims, of nature study, or of education in general, that these aims are ever before them, and who are so in sympathy with children as to be guided in their work by the way in which their pupils see and feel and think and do, will not go far astray in their methods. Without this appreciation of aim and sympathetic study of children, the best methods degenerate into mere devices.

"Why" is the most important question for the pupil as well as for the teacher. The education of the past has been too largely a study of "what." In history and biography we have studied facts and events, revolutions and battles and leaders. In science we have studied form and structure, have emphasized mere identification and classification. We are learning that history is also a study of causes and results, of the working out of great truths or principles, of gradual development or evolution. In science we are beginning to investigate more carefully forces and agencies, to watch processes, to emphasize action and change, life and function and adaptation, of which form and structure are but the results or the expression.

One leading characteristic of the "new education" is the pre-eminence of "why," and the subordination of "what," or the looking beyond and through the "what" to the "why."

What is the aim of nature study? We shall find that it is practically the same as the aim of other studies, or of education in general.

More than is the case with most other studies, probably, science, or nature study, deals with the individual child, and aims to develop each child as an individual. It places the material in the hands of each child, and expects him to see and think and tell for himself. Nature is many-sided; and when pupils observe for themselves, each will have a different point of view, will see a different side. The teacher will thereby be helped to realize the difficulty, the impossibility, and, finally, the viciousness, of teaching *en masse*, of teaching classes rather than individuals, and will recognize, respect, and at length encourage and develop, the individuality and self-reliance of the pupil.

In discussing aims it will be helpful to consider first the aims which have determined the character of much of the work in science, or nature study, in the past.

As men began to realize how dependent they were on the physical world about them, their physical environment, they were impressed with the necessity of becoming acquainted with that environment. The earliest recognized object of science, or nature study, or of study or education of any kind, was knowledge, the acquisition of facts.

As knowledge (using the term in the older and narrower sense), the acquisition of information or facts, was considered the great object of science or education in general, it was natural and inevitable to place great emphasis on the study of books as the storehouses of facts, and on memorizing as the simplest method of acquiring facts. For this reason most of the work in science and in all education was for centuries mere book-work. Even to-day in our schools the study of geography, which has been defined as the study of the physical environment of man, is very largely a mere memorizing of matter taken from books.

Our thoughtful teachers have long realized that knowledge thus gained through books alone, or through teachers and not through personal investigation, is exceedingly hazy and illusory. Too often it is not knowledge, but has only a misty semblance to it. Such knowledge "shall vanish away."

To science — that is, physical science — belongs the credit of most clearly demonstrating the haziness of the knowledge thus gained, and the weakness of this method of study. Science has introduced into our educational system the method of personal investigation, the laboratory method, as distinguished from the mere book or lecture method. Gradually the scientific method, or laboratory method, has been adopted in subjects not scientific, such as history and literature.

From this point of view, the introduction of nature study, of personal observation of nature, has been urged as the best preparation and basis for geography. It gives the children a knowledge, a genuine, personal knowledge, of the fundamental facts necessary for an intelligent study of geography.

Even with the laboratory method of ascertaining, making clear, and demonstrating facts, and assimilating the material gained, our teachers are learning that knowledge, accumulation of facts, as an ultimate aim in education, is exceedingly low, narrow, and unsatisfactory. No matter how clear or how well fixed in the mind the knowledge may be, we are learning that knowledge of our physical environment, or of anything else, is not necessarily power. We need more than knowledge, or more than this kind of knowledge.

The development of the intellectual powers of the child has become, or is becoming, the ultimate aim of many teachers; and the acquisition of knowledge, or of facts, has become of secondary importance. We are more and more endeavoring in our schools, from university to kindergarten, to have our students get more than facts; we are striving to develop their intellectual powers, — of seeing or apprehending for themselves, of thinking or combining ideas in their relations, of expressing or conveying these ideas to others, and of doing or making their ideas active or effective.

The same development or evolution of ideals or aims has, consciously or unconsciously, determined the character of the work in nature study, or elementary science, in our schools. At first teachers placed all emphasis on the importance of a *knowledge* of the facts of the physical world; and the schools have been flooded with Nature Primers and Nature Readers, and Hours with Nature, good, bad, and indifferent, to meet the demand of the school-men and school-women. Too often the study of nature has stopped with the reading of these books. Unfortunately, in many schools we have not yet passed beyond this first stage in the introduction of nature study.

A host of teachers have, however, realized the importance of a higher aim, and are insisting on personal, individual investigation, as opposed to mere book-work, as a means of developing the powers of the pupils, training them to see and think and express for themselves.

Science work, or nature study, has given the pupils something to work with, something on which and with which to develop their powers, something definite and tangible which they can see and think about and tell about. Nature study is a content study, and a basis for formal or expressive work.

The results of science work, genuine science work, — personal investigation, not mere book-work, — taught as a means of developing power, have demonstrated its great value. In hundreds of schools nature study has won and kept a place as an aid in developing the powers of the children. It has given not merely the clearer vision and more certain knowledge which come to those who walk by sight and not merely by faith, but the power, crystallizing into habit, of careful, exact observation; the corresponding power of clear and truthful expression in language or drawing, which must come when the impression is clear and exact, because based on interest and on actual observation; the habit of asking and seeking the "why" and "how" of the world around them; and, perhaps best of all, the marked improvement in individuality and self-reliance resulting from the consciousness of power.

More and more nature study is being, and has been, introduced into our schools as a basis for the expressive work of the school, — reading, writing, drawing, modelling. What the children see they talk about, write about, draw, mould, paint. Experience has demonstrated beyond possibility of doubt or question that when a portion of the time formerly given to the formal work in language, drawing, and other expressive studies has been devoted to nature study as a basis for these expressive studies, the work in these subjects has been greatly improved.

Nature study, considered as a means or method of acquiring a knowledge of our physical environment, and of developing power to control our environment and make it minister to our needs, is not merely an aid in other school-work, but is a preparation for practical life.

Our success in life as individuals depends to a very large extent on our knowledge of and power over our physical environment. Our dependence on physical forces and agencies becomes greater as civilization advances, and man learns to better control nature. The child of to-day must know more about steam and electricity than did the wise man of a century ago.

Our development as a race is very largely due to the fact that we have learned to harness natural forces, and make them do much of our work. With the aid of steam and electricity, the average man to-day can probably accomplish thirty times as much as did the man of a century ago.

The practical importance of a more careful study of science has long been recognized in higher institutions of learning, — in university, college, and high school.

If science is considered necessary for the few students in these institutions, why is it not necessary for the many who never get beyond the elementary school?

Of inestimable value in life is the power, and the habit which results from the constant exercise of power, of investigating for ourselves, of separating the true from the false, of distinguishing between essentials and non-essentials. Under no other condition is this so important as in a republic. Nothing gives this power to children as does genuine science work, simply because in science work, or nature study, more than in any other work, children can study *things* with their own eyes, really investigate and distinguish for themselves.

The question now arises, "Is the development of intellectual power the ultimate aim, the highest object, of nature study, or of education in general?"

The mother and the teacher very soon realize that the acquisition of knowledge and the development of power in any study are largely dependent on the interest aroused. With intense interest there is scarcely a limit to what the child can learn and do. Without interest, comparatively little can be accomplished. The more carefully we study children, — and their fathers and mothers, — the more we shall be impressed with the fact that the knowledge acquired and the power developed under any conditions are, in general, directly proportional to the interest aroused.

Nature study is no exception to this rule. The first essential is to gain the interest of the child. His senses form the gateway to his world. His senses always respond to interest, the gate always opens; with interest aroused, with senses alert, every power of the child responds, and there is scarcely a limit to what he can do. Nature study will never succeed until the child is interested.

Are the awakening of interest, the development of power, and the acquisition of knowledge, the highest aims?

Of what value is power without something above it or back of it to direct and regulate it? Power may do harm as well as good. The possession of power may be a curse as well as a blessing.

Goethe has said, "Nothing in the world is so terrible as activity without insight."

We may develop the power of observation in our pupils. If they are thereby only better fitted to see the evil and the vile, have we helped them?

We may train them to express their ideas more clearly, exactly, and effectively, and to better convey to others what they have in their minds. Unless at the same time we store their minds with ideas worthy of expression, and give them an impetus toward better, higher, nobler thoughts, their greater power of expression may be a curse to themselves and to others.

We give our boys and girls greater power to calculate and think and reason. If this is to be used to cheat their fellows, to influence others for evil, have they and the world gained or lost?

The more we work with children, and particularly with little children, the more we get into sympathy with them and look through their eyes, the more fully we realize that there are higher aims in education than the development of power. When we get into the primary school or kindergarten, such an aim seems incongruous, utterly out of place. We see instinctively, if we love and understand children, that such an aim is beneath them. Why?

As the primary teacher studies with her children, and studies her children, she discovers the necessity in all their work of interest, and of that highest form of interest, — sympathy. With perfect sympathy between herself and her children she has almost unlimited power over them. With the little folks in thorough sympathy with the bird or cat or plant they are studying, their power to see and think and tell is wonderfully increased.

This sympathy is peculiarly necessary in nature study. Without sympathy with nature, nature study may be even detrimental to the child, and disastrous in its effects on the child's environment.

If we merely aim to interest the children in nature, develop their powers of observation, expression, and thought, and give them a better knowledge of their physical environment, and stop there, the ultimate results may be of doubtful value. Our wild-flowers will be pulled up, our birds destroyed, our shade-trees mutilated ("sacrificed to the cause of science"), in the search for material. Our boys and girls may become, like many of their older brothers and sisters in the science classes of higher institutions, mere cold-blooded anatomists and collectors.

No; interest, power, knowledge, are not the highest aims in nature study. Preceding these, along with these, more important than these, must come the cultivation of the sympathies of the child. "Love is the fulfilling of the law" educationally as well as spiritually.

We shall find that we shall develop in the hearts of the children a sympathy with the world of nature in proportion as we lead them to care for or work for nature. We are apt to love best that for which we do the most, not merely, as is often assumed, that from which we receive the most. So keeping in view the cultivation of a sympathy and love of nature, we will give our children and pupils plants and animals to care for. A few seeds planted, watered, and watched over by the little folks, buds gathered and supplied with fresh water, a pet bird or kitten cared for by them, will be most helpful in developing a sympathy with the world of life.

Equally essential for the cultivation of sympathy with and love for nature is an understanding of what we receive from nature, an appreciation of what nature gives to and does for us.

Most closely related to the cultivation of sympathy with nature is the development of the æsthetic sense in our pupils, the appreciation of the beauty of their environment.

By beauty we mean, as shown in Chapter I, not merely the beauty of form and color and structure, but the far higher beauty of function and adaptation, or fitness for work, and that highest manifestation of beauty shown in the unity of all nature. The old definition of beauty was "multitude in unity."

In nature, as among men, "handsome is that handsome does," and in nature study we have constant opportunities to lead our pupils to realize that everything has a work to do, and to see how well everything is adapted to its work. Whether we are studying plant or animal or stone or water or air, every part has a a work to do, is fitted for its work, is doing its work.

We may study the clouds simply to give the children a larger knowledge of the phenomena of nature. We may use the study of clouds as a means or method of sharpening the intellects or developing the powers of the children. But the cloud study will mean more when we dwell also on their beauty of form and color, bring out the story they tell of co-operation of water and air and sun and wind, and give our pupils some idea of their place in the plan of nature, or of nature's Author.

We may analyze the dandelion, and learn all about its parts. We may study it in its relations to the past and future, investigate the work of its parts, and all the marvellous adaptations to insure fertilization and the formation of fruit. We may also dwell on its beauty of color and fragrance and function, and read with the children the beautiful poems inspired by the dandelion.

Which will do most for the child?

Wordsworth has said, —

"For I have learned
To look on nature, not as in the hour
Of thoughtless youth; but hearing oftentimes
The still, sad music of humanity,
Nor harsh nor grating, though of ample power
To chasten and subdue. And I have felt
A presence that disturbs me with the joy
Of elevated thoughts; a sense sublime
Of something far more deeply interfused,
Whose dwelling is the light of setting suns,
And the round ocean, and the living air,
And the blue sky, and in the mind of man:
A motion and a spirit, that impels
All thinking things, all objects of all thought,
And rolls through all things. Therefore am I still
A lover of the meadows and the woods,
And mountains; and of all that we behold
From this green earth; of all the mighty world
Of eye and ear, — both what they half create,
And what perceive; well pleased to recognize
In nature and the language of the sense,
The anchor of my purest thoughts, the nurse,
The guide, the guardian of my heart, and soul
Of all my moral being."

Considering the higher aim of nature study, we see the importance of correlating it with literature and art. Much of the most beautiful in literature and art has been inspired by nature; and for an appreciation of this, nature study is the best preparation. If we do not give our pupils the beautiful thoughts which others have gained from nature, if we do not read with them the poets and other nature-loving writers, we miss one of our greatest opportunities in nature study.

Along with this appreciation of the beauty of their surroundings, will there not come to the children a better understanding and better performance of what they owe to their surroundings? Will they not be more careful of flower and bird and tree? And will not their ethical nature, their appreciation of duty, be thereby developed?

Have we reached yet the highest aim of nature study?

Is that interest complete which does not attract the child toward the Author of nature? Is that knowledge complete which does not see in nature and through nature the Creator? Is that power complete which does not enable the child to see through nature nature's God, to realize that in nature study he is "thinking God's thoughts after Him;" to read better this other book of revelation, to tell better the story of a Protector and Planner which nature tells him? Is that sympathy complete which does not bring our pupils into closer touch, into harmony with Him who has breathed into all things the breath of life? Is that appreciation of beauty, that æsthetic sense, best developed which does not look above beauty of form and color and structure to beauty of adaptation and function; above beauty of function to beauty of co-operation and mutual helpfulness; above beauty of co-operation to the unity of plan; above the plan to the Planner?

Let us review in order the aims which should control in the work in nature study. So far as it is possible to arrange in tabular form aims which are so closely related and mutually dependent, which are all really subordinate to the great aim of nature study or education, character-building, we may summarize the aims of nature study, considering the development of the individual child, as: —

First. To awaken an interest and cultivate a sympathy with his physical environment.

Second. To cultivate the higher nature of the child, æsthetic, ethical, and spiritual, and lead him toward God.

Third. To develop his intellectual powers and form right habits.

Fourth. To lead the child to acquire a knowledge of his physical environment.

Considering the child in his relations to school, we may give as secondary or subordinate aims of nature study: —

First. To give the child an understanding and appreciation of nature which will enable him to enjoy and appreciate the literature and art which have been inspired by nature.

Second. To give the child clear impressions which shall serve as one basis for the expressive work of the school, — language, reading, drawing, modelling and arithmetic.

Third. To give the child a clear knowledge of his immediate physical environment which will serve as a basis for his work in geography, his study of his broader environment.

We must ever keep in mind that all other aims are subordinate to one, the highest. The study of nature misses its highest purpose unless it leads the child from nature up to the Author of nature. Unless the seen points the child to the unseen, unless from care and protection he looks to a Protector, through function and purpose and plan he sees a Planner, nature has not revealed to teacher and pupils its greatest thought, its grandest lesson, — eternal law, eternal unity.

CHAPTER V.

THE HIGHEST AIM OF NATURE STUDY: TO ADAPT THE CHILD TO HIS ENVIRONMENT.

In the previous chapter we have considered as the great aim of nature study or education in general the development of the individual child. If we stopped with the individual our outlook would be narrow. It is not until we think of the child in his relations to his environment that we get the broadest and highest views.

Even in discussing the development of the individual child, we have found that those aims are low which relate merely to the individual, and the aims become higher just in proportion as they bring the individual into closer relation with that outside himself. The acquisition of knowledge and development of power are comparatively low aims, because they relate to the individual. The cultivation of the sympathies, and of the æsthetic, ethical, and spiritual nature, is a higher aim, because it tends to bring the child into closer relations with his environment.

Now we want to consider the higher aim of nature study, — to perfect the relations between the child and his surroundings, or to adapt the child to his environment.

The environment of the child may be considered as threefold, — his physical environment, or nature; his intellectual environment, or man as an intellectual being; and his spiritual environment, or God. This division may be somewhat artificial, but it is very convenient. That education is incomplete which does not adapt the child to this threefold environment, — nature, man, God.

The question naturally arises, "What is meant by adaptation to environment?" In much of the work of the past we have assumed or have seemed to assume, that adaptation to environment means learning about our environment, so that we can control it, or make it minister to our material needs or desires.

Too often we have considered almost entirely our material needs, and have looked on nature, man, and God as means for supplying these needs. This has been most apparent, perhaps, in our attitude toward nature. Nature has been considered almost entirely as a storehouse of purely material riches. Our natural resources have been material resources. Forests have been lumber and little more except to the few, "the children, women, and poets" as some one has grouped those who see in forests more than lumber. The birds have been the farmer's bane or the farmer's friends according to the state of knowledge, but not often, except to the group before named, the sweetest singers ever heard, sources of joy and inspiration. The flowers

— most high-school teachers of botany have recollections of interviews with parents who did not want their children to waste their time studying such things. They wanted their boys to learn something practical.

But nature can do much more than minister to our material wants. If we will but let her, she ministers to far higher needs. To the eye that sees she comes full of beauty, a solace and inspiration, a messenger from above. The sunset and clouds, the frost and snowflakes, the leaves and flowers, the hills and valleys, the birds and bees, appeal to that in man which is higher than the mere material. Not until we gain from nature these higher riches, not until we can appreciate her beauty and the story she tells, can we realize what nature can give us. These higher gifts of nature we can appropriate without much regard to deeds or titles. No one needs a title to make his own the riches of the sunset or the beauty of the landscape. The amount of this higher wealth which we can call our own is only limited by our capacity for receiving or appropriating.

> I do not own an inch of land,
>   But all I see is mine;
> The orchards and the mowing-fields,
>   The lawns and gardens fine.
> The winds my tax-collectors are,
>   They bring me tithes divine,
> Wild scents and subtle essences,
>   A tribute rare and free;
> And, more magnificent than all,
>   My window keeps for me
> A glimpse of blue immensity,
>   A little strip of sea.
>
> LUCY LARCOM.

MY TENANTS.

I never had a title-deed
To my estate. But little heed
Eyes give to me, when I walk by
My fields, to see who occupy.
Some clumsy men who lease and hire
And cut my trees to feed their fire,
Own all the land that I possess,
And tax my tenants to distress.
And if I said I had been first,
And, reaping, left for them the worst,
That they were beggars at the hands
Of dwellers on my royal lands,
With idle laugh of passing scorn
As unto words of madness born,
They would reply.
I do not care ;
They cannot crowd the charmèd air ;
They cannot touch the bonds I hold
On all that they have bought and sold.
They can waylay my faithful bees,
Who, lulled to sleep, with fatal ease,
Are robbed. Is one day's honey sweet
Thus snatched ? All summer round my feet
In golden drifts from plumy wings,
In shining drops on fragrant things,
Free gift, it came to me. My corn,
With burnished banners, morn by morn,
Comes out to meet and honor me ;
The glittering ranks spread royally
Far as I walk. When hasty greed
Tramples it down for food and seed,
I, with a certain veiled delight,
Hear half the crop is lost by blight.
Letter of law these may fulfil,
Plant where they like, slay what they will,
Count up their gains and make them great,
Nevertheless, the whole estate

Always belongs to me and mine.
We are the only royal line.
And though I have no title-deed,
My tenants pay me loyal heed
When our sweet fields I wander by
To see what strangers occupy.

Helen Hunt Jackson.

In our study of nature with the children, in aiming to adapt the children to their environment, we can scarcely emphasize too strongly this most important step in adaptation, the training of our children to appreciate and appropriate the higher riches all about them. Not until they appreciate, not only the utility or practical value, but the beauty and symbolism, of their environment, are they fitted or prepared for real adaptation to environment.

This training to appreciate and appropriate all that we receive or may receive is only partial, one-sided adaptation. Not until we realize that adaptation implies something more than appropriation, will complete adaptation be possible.

Man has lived beyond the time when he centred the universe about this little world. But he still, to a considerable extent, regards his environment as a mere adjunct and servant to his little self. We have adapted ourselves to our physical environment by stripping our land of its forests, our air of its birds, our waters of their fish, by using up in the most reckless manner our natural resources. Nature has been our slave, from whom we could take anything, to whom we owed nothing. We have often adapted ourselves to our intellectual environment by getting from our neighbor all we could, and giving him in return as little as possible. Our adaptation to our spiritual environment has been equally one-sided and selfish. Too often we have taken all, and given the least possible service in return.

We are learning that such adaptation is in the end unprofitable, unwise, utterly wrong. The farmer soon learns that he must give to his fields if he would get the most from them. We are discovering as a nation that we must protect our forests, and are just beginning to plant where we formerly used our energies in destroying our trees.

The growing recognition of the brotherhood of man, of the fact that we are to an extent our brother's keeper, is an appreciation of the same principle. We are realizing better than ever before that our fellows are not merely instruments, tools to be used for our own development or advancement, from whom we are to take all that we can get. We owe something to them. Men are slowly learning to appreciate that what they get from their fellow-men depends very largely on what they give to them.

We like to think that the same idea is modifying our understanding of our spiritual relations; that a larger proportion of mankind is realizing that the church, or religion, is not a plan for getting as much as possible from our spiritual environment, and giving as little as possible in return. Do not a greater number than ever before regard the church as an opportunity for larger service? We think so.

Adaptation to environment means more than making our environment minister to our needs, getting from it all we possibly can, and giving the least possible return. We owe something to our environment, whether nature, man, or God; and adaptation is incomplete until we learn to recognize and perform what we owe.

We have considered as successive aims in nature study the acquisition of knowledge, or facts, the development of intellectual power, the awakening of interest, the cultivation of sympathy, the development of the higher nature, æsthetic, ethical, spiritual. We shall find that in the ultimate analysis these are all subordinate to the highest aim, — adaptation to environment. They all prepare for more complete adaptation to environment, to nature, man, and God.

The question now arises, How, through or by means of nature study, can the child be better adapted to his threefold environment?

The child is first brought into relation with the physical world. His early wants are physical. He gains everything through his senses, and they tell him only of his physical surroundings. Of his intellectual and spiritual environment he knows almost nothing at first. What he gains later comes directly or indirectly through the medium of his senses. In his earliest education we must use matter and methods which appeal most strongly to his senses. These we find in nature study.

The first step in adapting the child to his environment is to lead him to appreciate what he receives from nature, and what he owes to nature.

To do this we must first open his eyes to the beauties of the world about him, — the beauty not merely of form and color, but the higher beauty of use or work or function, and adaptation to work. It is not enough to merely talk or read to him about the world of sense. We must help him to *see* how much of beauty there is in the most common things; how much they have to do, and how well they are fitted for their work. The most common plants, — the bean and pea and dandelion, the plantain and burdock and thistle, — the trees and buds and leaves, the birds and insects and fishes, the stones at our feet, are full of beauty and grace if we will but look for them. When the child has watched the bean and pea grow from seed to fruit, and noted how each part has a work, and how well it does its work; when he has *seen* the buds emerge from their protecting scales, throw out leaf and flower, and go to work; when he has discovered how the dandelion feeds and protects and ripens her seeds, and finally scatters them to the four winds of heaven; when he has listened to the song of the robin or bluebird, and peered into her nest as she has fed her little ones, — he appreciates, as he cannot be led to appreciate in any other way, the beauties of his natural environment.

As the child understands better the beauty of his surroundings, the beauty of being, and the higher beauty of doing; as he discovers how much he gets from nature, he realizes better that he owes something to the world about him. He protects where he once destroyed. He takes care of the flowers which before he trod upon. The birds are his friends. He is learning to love them as he understands how much they give him. He is adapting himself to his physical environment; not merely appropriating, but giving in return.

We have already referred, in Chapter IV, to the importance and necessity of leading the children to express their appreciation by action. As they take care of plant and animal they will appreciate and realize what they receive from and owe to them.

Every mother and teacher who has studied nature with her children from this standpoint, knows how marked, in this respect, is the effect on the minds of the children, on their attitude toward nature; how quickly they respond, how soon they are brought into touch or sympathy with nature. If our work in nature study in the elementary schools does no more than strengthen or fix this attitude toward nature, it does much. If it does less than this, it does little.

How can nature study help the child to appreciate what he receives from and owes to his intellectual environment, man?

As this right attitude toward one part of his surroundings is fixed, as his sympathy with nature is broadened and deepened, it cannot but affect the attitude of the child toward the rest of his environment. He cannot learn to appreciate nature, and what he owes to nature, without being in a mental condition better to appreciate all of his surroundings.

Furthermore, nature, rightly studied, is, to the child at least, a symbol of his higher surroundings. As he sees how much Mother Nature does for her children, how carefully she protects and feeds seed and bud, leaf and flower, how she looks after, plans for, and controls plant and animal and mineral, Mother Nature helps him to better understand how much his mother and friends have done for him.

As the child studies nature, he learns to appreciate better what has been the source and inspiration of much of the most beautiful in literature and art. Nature study opens his eyes to much of the most beautiful part of his intellectual environment. One who, like the writer, has begun his right sympathetic study of nature in his adult years, when he could understand the effect upon himself, can realize that an appreciation of nature opens a new world in literature. Much in Bryant, Wordsworth, Longfellow, Tennyson, Lowell, Whittier, Helen Hunt Jackson, Lucy Larcom, Burroughs, Thoreau, and a host of other writers, which before meant little, has become full of beauty, because he has some appreciation of the world of nature which inspired these writers, and has read something of the story which nature told them.

Not less is the child helped to appreciate many of the beauties of art. He who never studies the landscape about him or the clouds above him, who scarcely looks at the sunset or notices the trees or flowers or birds, is utterly incapable of really appreciating the pictures which these have inspired.

Even more helpful is the right study of nature in leading the child to realize and perform what he owes to man, — his intellectual environment. He discovers that everything about him is doing, helping as well as being helped. The leaves, at first so carefully protected by scales and gum and fur, push out and go to work to help root and stem and flower, and soon begin to protect other buds and leaves. The flower, at first ministered to by every other part of the plant, learns as it unfolds that it has a work, a wonderful work, to do. From it new plants must come. The water is constantly helped and being helped. In the sky, in the stream, down under the ground, in plant and animal, it is always at work. Nature is a great mutual cooperation society, whose motto is, "Help and be helped." Is the child the only exception? or will he learn from nature the lesson that he not only receives much, but that he owes much?

These lessons come with most force direct from Mother Nature herself. She is the best preacher. The lessons thus absorbed, imbibed by the children often unconsciously, make a far deeper impression than the "Thou shalt" and "Thou shalt not."

As the child is thus learning to appreciate nature and man better, will he not be lifted toward the Author of nature? Will not the protection and care which he sees in plant and animal lead his mind to a Protector? As he discovers in everything about him purpose and plan, will not his thoughts be lifted toward the Planner? Will not his better appreciation of the beauty and function and unity of his physical environment, and his better understanding of his human environment, help him to appreciate better what comes from the Author of all, — his spiritual environment?

And will the effect stop there? Can it? As the child sees the wisdom and power of the Creator shown in his works, as he begins to appreciate the beauty and unity in all nature, as he realizes something of the infinite care with which leaf and flower and seed are planned and protected, will he not be drawn toward the Protector and Planner? Will he not better appreciate and better perform what he owes to the God and Father of all?

Others have expressed so effectively this higher value or æsthetic content of nature study that it seems appropriate in concluding this discussion to quote from two of our poets.

GRACE AND HER FRIENDS.

Your walk is lonely, blue-eyed Grace,
  Down the long forest-road to school,
Where shadows troop, at dismal pace,
  From sullen chasm to sunless pool.
Are you not often, little maid,
Beneath the sighing trees afraid?

"Afraid, — beneath the tall, strong trees,
  That bend their arms to shelter me,
And whisper down, with dew and breeze,
  Sweet sounds that float on lovingly,
Till every gorge and chasm seems
Thrilled through and through with fairy dreams?

"Fast to the slippery precipice
I see the nodding harebell cling:
In that blue eye no fear there is;
Its hold is firm, the frail, free thing!
The harebell's Guardian cares for me:
So I am in safe company.

"The woodbine clambers up the cliff,
And seems to murmur, 'Little Grace,
The sunshine were less welcome if
It brought not every day your face.'
Red leaves slip down from maples high,
And touch my cheek as they flit by.

"I feel at home with everything
That has its dwelling in the wood;
With flowers that laugh, and birds that sing;
Companions beautiful and good,
Brothers and sisters everywhere;
And over all, our Father's care.

"In rose-time or in berry-time,
When ripe seeds fall or buds peep out,
While green the turf or white the rime,
There's something to be glad about:
It makes my heart bound just to pass
The sunbeams dancing on the grass.

"And when the bare rocks shut me in
Where not a blade of grass will grow,
My happy fancies soon begin
To warble music, rich and low,
And paint what eyes could never see:
My thoughts are company for me.

"What does it mean to be alone?
And how is any one afraid,
Who feels the dear God on His throne,
Sending His sunshine through the shade,

Warming the damp sod into bloom,
And smiling off the thicket's gloom?

"At morning, down the wood-path cool
  The fluttering leaves make cheerful talk;
After the stifled day at school,
  I hear, along my homeward walk,
The airy wisdom of the wood,
Far easiest to be understood.

"I whisper to the winds; I kiss
  The rough old oak, and clasp his bark;
No farewell of the thrush I miss;
  I lift the soft veil of the dark,
And say to bird and breeze and tree,
'Good-night! Good friends you are to me!'"

Lucy Larcom.

O for boyhood's time of June,
Crowding years in one brief moon,
When all things I heard or saw,
Me, their master, waited for.
I was rich in flowers and trees;
Humming birds and honey bees;
For my sport the squirrel played,
Plied the snouted mole his spade;
For my taste the blackberry cone
Purpled over hedge and stone.
Laughed the brook for my delight
Through the day and through the night,
Whispering at the garden wall,
Talked with me from fall to fall.
Mine the sand-rimmed pickerel pond,
Mine the walnut slopes beyond,
Mine on bending orchard trees
Apples of Hesperides!
Still, as my horizon grew,
Larger grew my riches too.

. . . . .

A lover's claim is mine on all
I see, to have and hold,
The rose light of perpetual hills,
And sunsets never cold.

. . . . . .

Aloft on sky and mountain wall
Are God's great pictures hung.
Beauty seen is never lost,
God's colors all are fast.
The glory of this sunset heaven
Into my soul has passed.

WHITTIER.

CHAPTER VI.

THE LIMITATIONS OF NATURE STUDY.

The Two Centres of Education: Nature and Man.

IN the two preceding chapters the aim of nature study has been discussed, and its educational value brought out. So strongly have these been emphasized, it may seem that the writer considers nature study all-sufficient as a means of education; that, as has been said by another, "Nature studies contain in themselves the possibilities of a complete education, not excepting the fruits which have hitherto been ascribed to the humanities alone."

The educational value of nature study has been emphasized to bring into near and broad perspective a study which has been in the past very near the vanishing-point. In the great majority of schools to-day, nature study, the study of our immediate physical environment, is utterly ignored. There seems little danger for years to come that it will be made too prominent.

In the tendency seen in so many directions in our elementary schools to turn from "man study" (language, history, political geography) to nature study, there is a possibility, however, of going too far. The pendulum once started is apt to swing to the opposite extreme. Something of this has been seen in science work in higher institutions. From the old classical extreme, when a liberal education did not include any physical science, but was all language, mathematics, and history, the pendulum swung to the opposite extreme. Often a purely scientific education, without any attention to the humanities, has been regarded as the best. To-day many of our universities and colleges recognize that a broad, liberal education requires a due proportion of science and the humanities. The conviction is growing that an education purely scientific may be even more narrow than one purely classical.

Nature study is not all-sufficient. It has its limitations. Nature study, or science, does not contain within itself the possibility of a complete or well-rounded elementary education. Harm may be done to the cause of education, and the progress of nature study may be retarded, by emphasizing it too strongly at the expense of other studies equally important.

As has already been said, the child's environment may be considered as threefold, — nature, man, and God. With his spiritual environment, God, he is brought into relation, at least in his formal education, only through his relations to nature and man. If it is true, as has been asserted in the preceding chapter, that the highest aim of education is to perfect the relation between the child and his environment, then the immediate object of formal education is to bring the child into right relations with nature and man. Behind, beyond, above this is the perfecting of the relations between the child and God.

We may group all formal education about the two centres, — nature and man. The child must study and be brought into better relations with both nature and man; if he is not, his adaptation to his environment is to that extent incomplete or imperfect.

If all his education consists in the study of man, — his language, literature, history, geography, and methods of calculating and reasoning, — the education is narrow. It does not fit the child to understand, appreciate, or properly make use of or control, the physical world in which he lives. He is adapted to but part of his environment, and to that extent is only partly educated.

If the education of the child is limited to the study of his physical environment, nature study, or science, and the work growing out of this study, his preparation for life may be even more defective. If he has not studied man, his history, his literature and art, — that is, the use man has made of his physical surroundings, the beauty man has "half created, half perceived," in and from his environment, — if he knows nothing of man's conquest of nature, of man's social and political relations, and has learned nothing from the past experiences of man, then he cannot be adapted to his human environment, and is not well equipped for life with his fellow-men.

In so far as man neglects the sympathetic, reverent study of nature, his understanding of its Author will be defective or erroneous. In so far as he is ignorant of physical laws, he will fail to understand many spiritual laws of which physical laws are counterparts or downward extensions. In so far as he is unfamiliar with the phenomena of the physical world, he is unable to fully appreciate spiritual truths, or, at least, to convey spiritual truths in the most effective manner to those whose world is largely a physical world. The Great Teacher almost invariably used the simplest physical phenomena about him, those with which his hearers and all mankind were most familiar, — the sparrow, the lilies, the grain of corn, the mustard seed, — as the means or medium for conveying the highest spiritual truths. The teachers of to-day, whether in home or school or pulpit, and particularly those working with the little folks, who live so largely in a world of sense, can do no better than follow his example.

On the other hand, the study of nature alone, no matter how sympathetically and reverently pursued, does not give the child an adequate knowledge of his spiritual environment, does not fit him to appreciate all that he receives from God, nor to appreciate and perform all that he owes to God. In history he sees even higher manifestations of protection and care, of purpose and plan and a Planner, than in nature. Some comprehension of God's dealings with, and God's relations to, man are essential, and cannot be gained from nature study. It must come from and through "man study." Without this the child cannot be best adapted or related to his spiritual environment.

A complete education, then, even in the elementary school, must provide for the study of these two parts of the child's environment. The work of the school must be grouped about the two centres, nature and man.

How can or should this be done? It is much easier to gather school-work about one centre, man, as has been largely done in the past. Are these two centres equally important, should they be made equally prominent, throughout the school-life of the child? A little study of the child and his relations to nature and man will help in answering these questions.

With nature, his physical environment, the child is brought into relation very largely through his senses. Nature (as we use the term) is primarily a world of sense. The child sees it, feels it, hears, tastes, smells it. The plants, animals, minerals, the flowers, birds, and insects, the rocks and soil, the water and clouds, appeal to the eye and ear. He begins to see and hear and feel them as soon as he is born. His earliest education in babyhood consists almost entirely in becoming familiar with nature, this world of sense, through his senses.

Nature thus indicates unmistakably that the earliest education of the child should be very largely centred about and based upon that which appeals to his senses. Building on what he sees, and therefore knows, he can not only develop his power of seeing, but can exercise the imagination with which he is so richly endowed. He gives to bird and flower every human attribute, and makes the brook and valley he has studied a starting-point for wanderings by the great streams, and through the valleys of other lands.

Even in the earliest school-years not all his work, however, should be a study of nature. He must begin his study of man. But that must be largely limited to a study of man's relation to nature. From the study of what he can see, and therefore can understand, in his home and the home relations, he can pass to the homes of other children, — of Agoonack, the child of the north; of Gemila, the child of the desert.

Man, as an intellectual being, does not appeal to the little child. His early relations with mother are purely physical. He has little or nothing at first to give him any idea of man as a mind, or the possessor of an intellect; nothing to relate him to his intellectual environment. As he grows older, he begins to understand something of the mind of man, but through the medium of his sense perceptions. Not until several years after birth does he show much intellectual power. Not until then is he well fitted for the formal study of his intellectual environment. As his intellect develops, he is more closely related to the intellectual world about him; his intellectual environment becomes more important, and its study can and should be made more prominent.

If this is true, then the two centres of education are not equally important at all times, and should not be made equally prominent throughout the school course. In the earlier years of the school-life, nature should be made more prominent; in the later years, man becomes more important, and should be given more prominence.

Theoretically, perhaps, it may be difficult to tell just when the child's intellect is so well developed that he can pursue to the best advantage such studies as history and literature. As a practical question, however, these must be taken up not later than the fourth to the sixth year of school-life, or in the case of the average American child they will never be studied. Probably ninety per cent of our school-children never get beyond the eighth or ninth grade. Forty or fifty per cent end their school-life at the close of the fifth or sixth school-year.

The recognition of these two centres of education must largely determine the character of the work in nature study throughout the school course. At first the children must study nature just as they see it, putting all emphasis on personal observation, and on inference based on personal observation. Later, nature should be studied in its relation to man, — the discoveries man has made; the way in which he has grouped natural objects and phenomena, leading to systematic science; the use man has made and is making of nature, bringing out the practical side, mining, manufacturing, commerce, and correlating the work with geography and history; the thoughts which nature has inspired in other minds, leading to literature and art.

The work in the distinctively "man studies," such as history and literature, is similarly influenced by the recognition of these two centres. The earlier work in literature must be that relating to nature, or to man in his relations to nature. This the children can comprehend and appreciate. The earlier work in history will be a study of man's relation to nature, how he lives, and how much nature has helped man. For the social relations, except those grouped about the home, the little child is not ready. He knows nothing about them. He cannot understand the history of the intellectual and social struggles and development of mankind. That must come later.

The grouping of the child's school education about these two centres should be, and is to a considerable extent, recognized in all school-work. The expressive work of the school — reading, writing, drawing, moulding — must, in the earlier years, be largely based on what the child can see, and largely grouped about nature as a centre. Later he is better fitted to understand, talk, and read and write about his intellectual environment, man.

Geography must be at first physical geography, the study of the earth itself, beginning with the immediate physical environment of the child. Later he is prepared for political and commercial geography, the earth in its relations to man.

The first limitation of nature study depends on the fact that it includes an adequate study of but one part of our environment, — nature. Through nature study alone the child cannot be most closely related or best adapted to all his environment. Hence it cannot be made a basis for a complete, well-rounded education.

The second limitation of the educational value of nature study, or science, depends on the fact that it does not provide for any adequate study of the experiences and examples of the past, and does not impress those lessons and truths which can be most readily and effectively gained from the study of human experiences and human examples.

The third limitation of nature study depends on the fact that while it may be, with history and literature, a basis for other studies of the school, — reading, writing, drawing, geography, and, to some extent, arithmetic, — it does not necessarily provide for adequate formal work in these studies. It is a content study. It gives matter or ideas. Through the other formal studies these ideas must be related and expressed. In nature study or literature or history, the essential thing is the idea; in the formal studies, the important thing is the form, means, or method of expressing or relating the ideas.

When the child has studied the robin, and is writing about it, the ideas he expresses are gained from nature study; but he must know something of language, of spelling and capitals and punctuation, to express these ideas properly.

It may be possible to make the formal studies — such as language, drawing, and arithmetic — entirely incidental to the content studies, — science, literature, and history. In every lesson in nature study the child should be studying, often unconsciously, language.

Most lessons in history and literature may be made lessons in geography. The experienced, well-equipped, far-seeing teacher may possibly entirely dispense with definite, formal lessons in language, — spelling, capitals, punctuation, grammar, — drawing, geography, and arithmetic, and teach them as incidental to nature study, history, and literature.

But the average teacher cannot do it to advantage. The inexperienced teacher is almost certain to fail in the attempt. In not a few schools the attempt has been made to teach all language work incidentally. The result has almost invariably been detrimental to the language work. In some schools arithmetic has thus been taught incidentally as an adjunct to nature study. Very rarely have the results been satisfactory.

In the average school, with average teachers, under average conditions, there must be more or less formal work in the formal or expressive studies, work supplementary to or independent of the work in these lines based on the content studies. The amount of this formal work which may be necessary depends on the wisdom, tact, experience, and breadth of the individual teacher.

The limitations of nature study depend, in the ultimate analysis, on the fact that it does not include any adequate study of one division of the child's environment, man; that it does not give the child the benefit of the experiences of the past; and that it does not, under average conditions, provide for adequate work in the formal studies of the school, particularly language, drawing, and arithmetic.

CHAPTER VII.

PRINCIPLES DETERMINING METHOD IN NATURE STUDY.

THE discussion of almost any subject involves the consideration of three questions, — "What?" "Why?" "How?" We have answered two of these questions.

The consideration of method involves three topics, — the study of material, the selection of material, and the arrangement of material and formulation of a course in nature study. The term "method" is frequently restricted to the first of these, the method in studying material. This may be discussed under three main heads: First, the presentation of matter to the children; second, the expression by the children of what they have learned, involving a consideration of the methods of relating nature study to the expressive work of the school, — language, drawing, moulding, painting, music; third, the method of relating nature study to other school-work, particularly literature, geography, and arithmetic.

In this and the next chapters we propose to consider the principles which must largely determine all method; in the two chapters following these we can study the application of these principles in the presentation of matter to the children, taking up in later chapters the other phases of method.

While our method must be determined by our appreciation of aim and understanding of children, it will be modified by other elements. It seems wise, therefore, in discussing method, to consider in order: —

First. The aims of nature study or of education in general, discussed in Chapters IV and V.

Second. Those characteristics or laws of child nature and child development most important, or having the greatest influence, in determining method.

Third. The other conditions which may modify method. These affect more particularly the selection and arrangement of material. They are considered in Chapter XIV.

The ultimate aim, as discussed and formulated in Chapter V, is: To adapt the child to his threefold environment, — physical, intellectual, spiritual, — or, stated more definitely, to train the child to appreciate what he receives from, and to recognize and perform what he owes to, nature, man, and God.

Considering the individual child, the following subordinate aims were formulated in Chapter IV, all included in the final aim, already stated: —

First. To awaken the interest and cultivate the sympathy of the child.

Second. To develop his higher nature, æsthetic, ethical, and spiritual, and lead toward God.

Third. To develop the intellectual powers of the child, and form right habits.

Fourth. To gain a knowledge of his environment.

Subordinate to the general aims enumerated are others relating to the material. Each series of lessons and each lesson in nature study has as its immediate aim the presentation of certain matter, and the developing of certain ideas and relations. The teacher is planning to study with her pupils the robin. The immediate aim may be to discover all they can about the robin. Back of that may be the emphasizing and clinching of those points of structure which will help the children to compare the robin with other birds. Back of this is the putting of the robin in its proper group or order of birds, relating this group to other orders of birds, comparing birds with other backboned animals, and finally finding their place in the animal kingdom. Above all these aims is the development of the powers of the child, — the powers of discrimination, judgment, and classification, and of reducing to unity. Highest of all is the training of the child to use these powers for the good of himself and of the universe of which he is a part. Each lesson should have an immediate aim or point, subordinate and well related to the aim of the series of lessons, and all planned and conducted with reference to the ultimate aim.

The relation of aim to method and of subordinate aims to general aim has been illustrated in the lessons on the rabbit, Chapter II.

The method of each individual teacher in presenting material to her pupils, or in selecting and arranging or relating topics for study, will be mainly determined by her power or habit of looking from and through immediate aims to the higher ultimate aim. If she can see little farther than the examination, she will find little place for nature study, and have little use for method. Her method will be a process of "cramming." If she thinks mainly or only of developing the intellectual powers of her pupils, — that is, the powers of observation, expression, and thought, — she will understand the uselessness of "cramming." She will insist on individual work, individual seeing and thinking and telling, but will neglect the highest aspects or content of nature study. Her method will be rigidly scientific. If she thinks only of preparing her pupils for practical life, of fitting them to earn their bread and butter, she will dwell on the economic relations of what she studies with her boys and girls. If she keeps ever before her the ultimate aim, the fitting and training of the children for the best possible relations with all their environment, nature, man, and God, she will find time and place in her plan of work for that which will appeal to and develop the higher nature of her pupils, as well as for that through which they may gain useful knowledge and develop power.

It is important that the pupil, as well as the teacher, have a definite aim. His aim may be immediate and narrow, while the teacher sees the higher aims; but, in general, the pupil will do definite work in proportion as he realizes a definite aim. The pupil who does not know the aim, is like the child who is taken out for a walk without any objective point. Both wander about aimlessly. The pupil who, at the beginning of the lesson, is impressed with the aim of the work in hand, who knows exactly what he is looking for or trying to do, like the child who knows he is going to grandma's or to the toy-store, is much more apt to go directly toward his destination. When they are asked to study the buttercup, most children will do very little. When they understand that each pupil is to see how much he can discover about the parts of the buttercup flower, what each part does, how it does it, how it is fitted for its work, each is much more apt to observe and think for himself.

The aim must be stated in such a form, however, as not to tell the pupils what they should discover for themselves. When the children are told, "To-day we are going outdoors to discover how and from what dirt or soil, is made," they are given something definite to do, and are apt to do and think much more than if they are told, "To-day we will find that rocks break down into soil or dirt, and that leaves decay to form soil." In the second case they do not go out to investigate for themselves, but simply to verify what the teacher has told them.

Now comes the question, What characteristics of the child mind are most marked or what laws of child development have the most weight in determining method?

In genuine nature study the child is studying under the most natural conditions. He is gaining knowledge for himself through his senses, the natural method.

In no school-work do teachers have better opportunities for studying children. Experience has shown that nature study, more than any other work in the elementary school, leads the teacher to study her children and adapt her methods to them. In nature study, genuine nature study, teacher and pupils are working together, fellow-investigators of truth.

In such child study we discover certain characteristics or laws in the development of children (and almost equally marked in the adult) which determine method and require special consideration. These are: —

First. Sense-perception, as determining the medium through which, and the method by which, the child must originally gain his ideas or impressions or percepts.

Second. Apperception, as determining the means or method by which new ideas must be assimilated and incorporated with the old ideas, forming concepts or general notions.

Third. Interest, as determining the condition for and the method of gaining the most effective sense-perceptions, and of relating these percepts in apperception.

Fourth. Imagination, the power and process of forming mind pictures or mental images of what is seen or perceived (visualization), of recalling or reproducing these mind pictures (memory or reproductive imagination), and of modifying and combining the mental images of what has been perceived so as to picture what has not been perceived (constructive imagination).

Fifth. Sequence, the relating of ideas in a series, as determining, or rather expressing, the order in which the mind most readily receives and retains ideas or impressions.

Sixth. Unity, combining or merging diverse ideas into one, the condition to which the mind strives to reduce all ideas, and with which alone the mind is satisfied.

Seventh. Expression, as determining the means by which the child can convey his ideas to others, and at the same time fix or impress these ideas in his own mind, and gain power to get ideas from others.

By what we may call the law of sense-perception, we mean that the child must originally gain his ideas through his senses. All entirely new matter must come through his senses.

When we attempt to give the child new ideas through the artificial symbols which we call words, we often violate this law, and fail in our work. This law is of the greatest importance and widest application in science, or nature study. True science, or nature study, probably more than any other other line of work, must be founded and built upon sense-perception.

This is most essential in work in primary grades, and in any grade when beginning nature study. In later study, much can be founded or built upon the sense-perceptions and the mental pictures gained in earlier work.

Just here special care is necessary. Unless teachers take every precaution, make sure that pupils see with their own eyes, instead of merely listening or absorbing, all later work will be weak, because built on weak foundations.

The education of the past has been almost entirely an education of listening and absorbing, and appropriating, not of seeing and getting for ourselves. Teachers have learned to depend on books. In the writer's experience with teachers, one of the most common questions has been, "Where can I find a book which will tell me all about it?" Teachers have *given* to their pupils, instead of leading the pupils to *get* for themselves. In nature study the first great struggle of teachers will be at this point, — to overcome the habits so firmly fixed; to allow the younger pupils, and encourage and compel the older pupils, to use and depend on their own senses, to really base their work on sense-perception.

The necessity of basing all nature study on sense-perception, of laying the foundations in actual seeing and observation by each pupil, must greatly influence method; it must largely determine the selection of material and the order of study. Other things being equal, we must select for study that which can be best perceived or seen, and begin our study of anything with that which appeals most to the senses. This has been illustrated in Chapter II.

It must be remembered, also (as was brought out in Chapter III), that knowledge must be based not merely on sense-perception, but on "clear and certain perception." Too much emphasis cannot be placed on careful, exact observation, so far as the children are capable of exact work.

The law of apperception is an expression for the fact that the mind receives and retains those ideas which are or can be related to what is already in the mind, and, further, that it changes what it thus retains, connects it with, and makes it like, what the mind had before.

What any one sees depends on what he has already seen, what is already in his mind. Looking at the leaves on a tree, the artist may see the shades of color and play of light and shade, and little more; the botanist may see the resemblance to leaves of related plants, or perhaps their special adaptation to their work or function; the child may see only the movements of the leaves in the wind, or their bright colors, or the wreath he once made from them. All may look at the same leaves, and yet each sees something different. Each sees with and through that which he has already seen.

In this respect the mind is much like the body. No matter how much or what kind of food is placed before or taken into the body, the body only retains that food which it can assimilate; that is, relate to and make like what is already a part of the body. Apperception is thus the mental equivalent of physiological assimilation.

In the ultimate analysis the laws that we have enumerated depend, very largely at least, on apperception. We have seen that sense-perception depends on apperception. Interest is based on apperception. The child is interested in that which appeals to him; that is, in that which can be related to something already in himself. This is the reason why children are so much more interested in life and action than in mere form and structure, and why young children are so much interested in nature's babies. Imagination can only use the material or ideas gained by perception, and modified and related by apperception. The law of sequence results from apperception. By sequence we mean bringing matter to the child step by step in such an order that each new idea may be most clearly apperceived, that is, seized by and correlated with the mass of ideas which the previous steps have either given to the mind or brought into consciousness. The law of unity is simply an expression for the tendency which the mind has to relate everything which it perceives. The more closely the relations are established in all directions, the more perfect is the resulting unity. We shall find later, in our discussion of expression, that methods of expression must be determined largely by reference to the same principle of apperception.

The law of apperception must, then, very largely determine methods in nature study. To get the best results, we must not merely bring the matter before the children where each child can see it, — that is, base our work on sense-perception, — but we must call up, bring into consciousness, by our questioning, or by encouraging the children to talk freely, what is already in their minds relating to the material; find out what the children already know, and take hold of and emphasize those ideas which will make the best foundation for the new matter we want to present. This is most essential when working with young pupils. The little folks see so much more in germinating seed or developing bud, when they have connected the plant babies with the babies in their homes, — the way in which their baby brothers are cared for and fed and grow.

In any work which requires the pupils to think rather than to merely see, our success as teachers will largely depend on our power and habit of calling up the apperceiving ideas or concepts of the children, and building on these. As illustrated in the study of the rabbit in Chapter II, pupils understand much better the movements and limbs and feeding and teeth of the rabbit when they are related to their own body and way of moving and eating.

We see the wisdom, considering this same principle of apperception, of reviewing at the beginning of each lesson those parts of previous lessons on which the new lesson must be built or based, of being sure of our foundations before beginning new work.

The law of interest, — that the mind most clearly receives or perceives, is most deeply impressed by and most strongly retains or apperceives, those ideas which excite or are accompanied by interest, — has been strongly emphasized in the discussion of aim. In general, the surest evidence of interest is attention. Until the teacher has attention she can accomplish comparatively little.

No matter how careful the teacher is to bring the material before the child, to make sure that he sees, and to build on the foundations already laid, on the apperceiving concepts in the child's mind, the ideas gained or the impressions made will not be most clear and strong unless the child is interested.

On the other hand, the more the work in nature study is based on sense-perception, on what appeals to the senses, and the more the new is built upon and related to the old, is based on apperception, the more, in general, will the child be interested. Interest, particularly sustained or habitual interest, is one of the surest evidences that work is being presented in accordance with psychological laws. Absence of interest shows, in general, that something is wrong; matter or method is not adapted to the children.

Just as apperception is the mental equivalent of physiological assimilation, so interest may be considered as the counterpart of appetite. With adults appetite and interest are oftentimes not considered essential. The body and mind of children will not get proper nourishment without appetite or interest.

With interest aroused and senses alert there is scarcely a limit to what the child can do. In no other work is interest more essential than in nature study. In no other study will the teacher be so apt to be impressed with the educational value of interest as when she and her children are studying nature together under natural conditions, and following natural methods. In much other school-work the conditions and methods are unnatural, and the importance of interest is not recognized or realized.

Sympathy is but a higher active form of interest.

The more we can bring our pupils into sympathy with the dandelion and rabbit, with the world of life about them, the better the results. Sympathetic interest, as distinguished from mere intellectual curiosity, is a great aid in nature study.

As pupils grow older, we can depend more and more on what may be called secondary or indirect interests, — the ambition to succeed or to prepare for life, the desire to please parents and others, the fear of the disgrace which failure may bring. This indirect interest is not so helpful nor important at any stage in education as immediate, direct interest.

A most practical question is, How can the children be interested, and how can they be kept interested?

As has been said, the first essential in gaining and maintaining interest is to present matter which the children can understand, for which they have apperceiving concepts, and to present it in such a way as to most clearly relate the new matter to the old.

Novelty or newness usually arouses or stimulates interest. Young children particularly are more interested in new things. For this reason they require frequent change. Their interest cannot be very long sustained in one thing. As children begin to think more, new ideas as well as new objects attract them, new points of view, new relations in which familiar objects are studied, new beauties of form and color and function and adaptation, unsuspected before. The commonest, most familiar things, such as the dandelion, become new, when thus studied in a new light.

A third source of interest is participation, or self-activity. Children are interested, in nature study or anything else, in proportion as the teacher leads them to see and think and do for themselves. The child who makes a new discovery with his own eyes, or works out for himself a new idea or thought, is much more interested by and because of this self-activity, than he who simply absorbs from book or teacher or fellow-pupil. In nature study the children are much more interested in material which they have gathered or cared for themselves. The more a teacher can lead her pupils to get and take care of their own plants or animals or stones, or make their own apparatus, the more will they be interested. The more the children discover for themselves new facts, the more they work out the "why" and "how" of what they have discovered, the more the pupils, rather than the teacher, compare and generalize and deduce principles or laws, the greater will be their interest.

The interest will be increased, more especially with young children, by emphasizing in nature study the human or personal element, and particularly the child element. We can study the plants and animals, not as mere things, but as beings with human or child attributes or characteristics. Even water and snow and frost, lifeless things, can oftentimes be endowed with human desires and sympathies. The poets thus personify flower and tree, and raindrop and stream. In the childhood of the race all mankind personified nature. The children naturally do the same. It is often most helpful to allow or encourage children to thus personify, beginning always with facts gained through perception and elaborated by apperception, but letting imagination add flesh to what might otherwise be dry bones. In the study of cotton, the cotton-pickers and their pickaninnies and homes and life are more interesting than the mere process of planting and cultivating and gathering cotton. The processes of lumbering mean most when the study is centred about the lumbermen, the human element. These give connection and life to the processes.

We come now to the place of imagination in determining method. When our boys and girls have seen what they can about the dandelion blossom, and, by relating what they have seen to what is already in their mind, have gained a fair idea of the number, size, form, and color of its parts, they should have a mental picture of the flower. If this picture is to be of much value, they should have the power of bringing it into the mind, or rather into consciousness, again, when the blossom is not before their eyes, repeating or reproducing it at some later time. But this power of repeating the image or mental picture is of comparatively little value if the pupils can only repeat it exactly as they first saw it. It is necessary to take from that picture some features not essential, such as the size of the yellow disk, which varies in different specimens, and to add points noticed in other dandelions, so that the children can gain the general idea or general notion of dandelion blossoms, as distinguished from that particular blossom. Or they may have to add to the picture of the flower those of the other parts of the plant to form a picture of the plant, or those of other stages of growth to understand its life history. Finally, as was shown in Chapter I, the images of the dandelion must be related to what the mind knows about its environment.

This process of relating to other mind pictures, omitting some features, adding others, combining and modifying, may be continued until we get the beautiful series of pictures embodied in Lowell's "To the Dandelion."

The power or the process of repeating or reproducing the images of what has been perceived and apperceived is memory. The power or process of relating and combining these images, selecting parts of some, adding to others, combining parts of several to form a mind picture of what has not been perceived, we call imagination. The distinction between memory and imagination as thus defined is not very sharp. Frequently imagination is considered as including both memory — then called reproductive imagination — and imagination proper, distinguished as constructive imagination. Both have a most important part in determining method in nature study or in any other subject.

We recognize the importance of memory, or reproductive imagination, in all education. The education of the past, and much of the education of to-day, has relied too much on memory of words rather than of sense-percepts, memory which has very little sense-perception back of it. Too often children have memorized facts, definitions, formulas, — words, words, words, — with very little real content in them. Nature study, or science, is a protest against this kind or form of education. For words it would substitute real ideas, sharp, clear mental pictures, based primarily on sense-perception, and would use words as the means of clothing and expressing or gaining ideas.

In the reaction against too great dependence on word memory, there is often a tendency toward the opposite extreme. In emphasizing sense-perception, we are prone to overlook the importance of memory as an educational factor, and to neglect that necessary drill in reproducing what has been perceived and apperceived. This tendency is very evident in much of the elementary science work in our schools. It is often assumed that when children have seen and understood, little more is to be done. Seeing and understanding are or should be but the foundation and preparation for larger and broader seeing and understanding; and this larger view is only possible when children keep in mind or remember the essentials of what has been learned before, and constantly relate them to what is newly acquired.

To train the memory, — that is, to insure the repeating or reproduction in the mind of what has been seen or otherwise perceived, — nature points out three means or methods: —

First. The original picture or impression should be as clear and sharp as it is possible to make it. The pupil who has examined a flower carefully will remember much better than he who has merely glanced at it. What cannot be clearly seen by the children, such as the structure of the individual florets of the dandelion, is apt to be soon forgotten.

The clearness of the mind picture can be ascertained, and the power to recall it developed, by occasionally testing the power of the pupils to visualize; that is to form a mind picture of what is not before their eyes. After looking intently at some simple object, such as a leaf or a piece of apparatus, the pupils should describe it, or draw it from memory. Occasionally it will be helpful to have the pupils make a "conceptional drawing" of some simple familiar object at home, such as a tea-kettle or a lamp, and afterward compare their drawing with the object, and correct errors.

Second. Each important idea should be related with many other ideas, so that it may be recalled through or by means of any one or more of these. What is isolated or stands by itself is soon forgotten. What has been seen about the dandelion will be remembered much better when the plant is studied, not as a mere isolated structure, unrelated to anything else, but as related to its environment, soil and sun, and wind and insects, and to other plants. Its green cup is better remembered when related to its habit of closing at night, or in a storm. Any point of structure is better remembered when related to its function. When the children understand what the veins do for a leaf, that they support and carry food to each part, they better remember the plan of veining and the fact that a branch vein extends to the apex of each division of a leaf. We see here another reason for emphasizing the "why" in nature study.

Third. That which is most important, and should therefore be remembered, must be frequently repeated or reviewed. Here we see the necessity for drill. Because of the first law of memory, stated above, the review will be most effective when the images are fresh and clear. Because of the second law, that review is best which emphasizes relations and not merely facts. Hence each lesson should close with a summary, gathering up, bringing together, and relating the important points brought out. The first step in each lesson should, in general, be a review of the previous lesson or lessons, or at least of those portions of previous lessons on which the new work depends. So, also, each step in a lesson should be reviewed and stated clearly before passing to another step. This summary tests the clearness of the impressions, brings out the relations of the ideas or facts, and helps to fix them in the mind by having them repeated.

Constructive imagination, or imagination proper as distinguished from memory, differs from the latter in that it not merely repeats the mental images of what has been seen or perceived, but takes from, adds to, combines and recombines them, forming a picture of what has not been seen. It is only through imagination that we are able to become acquainted with that great part of the universe of which our senses alone give us little direct knowledge. It is imagination which helps us to look into the future, just as memory enables us to recall the past.

Imagination plays a most important part in mature science, as Professor Tyndall has shown in his essay on the "Scientific Use of the Imagination." On imagination, applied to and tested by facts, controlled by reason, depend the grandest conceptions and generalizations of the human mind, — the law of gravitation, the nebular hypothesis, the theory of evolution.

On the other hand, imagination not based on facts, or not controlled or directed by reason, is exceedingly harmful.

In the reaction against the education of verbal memorizing and return to the natural education of seeing, there is a tendency to discredit the educational value of imagination. Not infrequently scientists aver that it is utterly wrong to encourage the children to put into nature anything they cannot see; that, for instance, the lessons in elementary science which emphasize or dwell on the idea of protection in the study of the buds of pussy-willow or horse-chestnut are absurd and unscientific. As a fact, without imagination we could get no conception of life processes, of which only the results can be directly perceived.

Nature, however, endows the child with a strong imagination, and indicates its importance as an aid in his education. Imagination is the instrument by which the child looks from and through his little world of sense to the greater universe beyond his childish senses, for which he must be prepared. Through his imagination he modifies and combines the pictures which come to him through his senses, and thus gains higher, wider views, somewhat as he unites his letters to build words and form sentences. This faculty must be cultivated and directed, not neglected or deadened.

The practical question is asked, How can we most effectively use and cultivate the imagination in our work in nature study? Much of what has been said regarding the training of memory applies also to the cultivation of the imagination.

What is imagined or imaged must be based on and related to what is seen or perceived. The teacher who would train her pupils to picture what they have not seen must first lead them to combine into a clear picture what has been seen. They can only really imagine the lion and its habits when they have carefully studied the character and habits of such an animal as the cat. They can gain some idea of the Mississippi Valley through an examination of some brook or river-basin near their home. The pupils cannot imagine the processes by which sap is carried through the plant until they have seen experiments on capillarity and osmosis.

On the other hand, if we are to cultivate the imagination we must not stop with what is seen, but must frequently lead from what is perceived to what must be imagined. After studying the hairy seeds which the children can see, such as the dandelion and thistle and milkweed, it is wise to pass to the cotton-seed, with much longer hairs, which they must usually imagine. From the cotton-seed they can be led to picture the cotton-plant, the cotton-field, and perhaps the cotton-picking.

As describing or drawing from memory trains the memory, so describing or drawing what the children have read about, or have been told, but have never seen — that is, making a conceptional drawing — may help in cultivating the imagination. A description by the children of a cotton-field, or a drawing to represent the children's mind picture of the cotton-boll, shows teacher and pupil whether the picture in the mind of the pupil is clear and correct or vague, and tends to develop the power to picture or image or imagine.

Because the child can most readily imagine that which is most like what he already knows, it is easier for him to gain or form mental pictures of what is alive like himself, and of those things which are considered as having the attributes and relations with which he is familiar in his own life. Hence, as has been said before, it is natural, and often very helpful, for the child to personify; to endow animals and plants, and even lifeless nature, with human attributes. The more he thinks of them as living, working, helping, dependent, like himself, the better can he imagine and understand their life. Often he delights in imagining himself to be a leaf or plant or squirrel or raindrop, or in having these tell their own story.

One of the most effective aids in cultivating the imagination is literature. On the other hand, one of the main essentials for an appreciation of literature is a vivid imagination. The value of literature, as a means of broadening and uplifting the ideas and thoughts and pictures gained from nature study, is illustrated in the study of the dandelion in Chapter I. Lowell's "To the Dandelion" leads into a new world, if the reader has seen or experienced enough, and has an imagination sufficiently trained, to picture what the poet expresses. Genuine literature can be distinguished from mere prose or rhyme by the extent to which it gives broader, higher views, opens new vistas. That which merely gathers up what has been already perceived or apperceived, lacks one great essential of literature.

If we realize the importance of cultivating the imagination of our boys and girls, of leading from the seen to the broader, more uplifting unseen, if we appreciate the higher aims of nature study, the importance of cultivating the higher nature of our pupils, we will in our nature study make use of the best literature, and so study it with our pupils that they will be able to see something of the pictures the authors have seen.

CHAPTER VIII.

PRINCIPLES DETERMINING METHOD IN NATURE STUDY (CONTINUED).

HAVING considered in the previous chapter the influence of sense-perception, apperception, interest, and imagination in determining method, we are prepared to discuss the relation to method of sequence, unity, and expression.

Sequence is but a continuation or repetition of the process of apperception. The mind, like the body, accomplishes most when it builds and is built in order, or proceeds step by step. Sequence is building in order, founding each new part on the previous part, relating each new step most closely to preceding steps.

To insure sequence, several precautions are necessary; certain errors, common in teaching, must be guarded against.

We must be sure that all necessary foundations are laid. The builder who discovers after he has partly finished the superstructure that he has forgotten or neglected to support some part, and is compelled to go back and strengthen or add to his foundation, always loses time, and usually has a weak structure. The teacher who continually finds that in previous lessons she has neglected to lay some of the foundations on which present work must be built, and who is frequently compelled to interrupt her advance work, and go back to lay the foundations for it, cannot do the best teaching.

In studying the dandelion, unless the children have observed out-of-doors the closing of the flower, the growing of leaves and flowers away from the shade and toward the light, and the arrangement of the leaves to catch the rain and direct it toward the root, a lesson on the relations of the dandelion to sun and rain is almost useless. No foundations have been laid for it. The value of sequence or continuity of thought in individual lessons and in series of lessons is illustrated in Chapter II on the study of the rabbit.

A second error often committed by teachers, and particularly by teachers of young children, consists in attempting to take several steps at once, or to jump from point to point. Adults learn to take long steps, to go up-stairs two or three steps at a time, to take great leaps. Children must first creep, then take short steps, and after a time learn to run and jump. Particularly when climbing (and education is a process of climbing) they must progress step by step. They can jump or fall downward, but not upward.

What is true of the bodies of children is equally true of their minds. The mind, however, is much later than the body in attaining the stage of development when it can habitually jump or leap.

The adult teacher habitually, but often unconsciously, makes mental jumps in her line of thought, paying little or no attention to the intervening steps. When the teacher assumes that her pupils can take the same leaps of thought that she does, she either fails entirely, or, if she is strong, pulls her pupils off their feet, and carries them along with her, instead of training them to walk for themselves.

Only as the teacher analyzes her leaps, goes back in her experience to the time when she had to go step by step, studies the steps by which her children progress, and then adapts herself to them and tries to keep step with them, will she be most successful in training her pupils to take longer steps, and finally to leap for themselves.

Such an analysis by the teacher of the successive steps by which she gained her ideas or attained her present state of knowledge is particularly essential in the case of the teacher whose education has been almost entirely an education of books. In mere book-work, pupils habitually make great leaps, accepting the ideas and conclusions of the author without looking at the steps which lead up to them. For this reason, and many others, the teacher should study nature, not merely books, in preparing for nature study; she can best prepare by studying with a child. She can then see just how the children creep and step in their observation and thought. The teacher who prepares for her lesson in nature study by merely reading what "the book says," will almost certainly fail in adapting her work to her pupils, and in leading them to see and think for themselves.

This tendency of the adult mind to leap is illustrated constantly. We associate the evaporation of water with the formation of rain and snow, and are apt to expect a child to do the same. If he does he merely takes the relation on faith, as we probably took it originally. Between the evaporation of water and the falling snow there is a long series of intermediate steps: the process and conditions of evaporation; condensation and the formation of water-dust, mist, fog, cloud, and raindrops; the process of freezing and crystallization, by which frost and the snowflakes are formed; perhaps also the work of heat and gravitation, of the sun and wind, in the formation of snow from evaporated water.

At times, of course, the path is too steep, or the climbing too difficult, for the children. Then the teacher must carry them. However, children are much better climbers, and need much less carrying, than the average teacher assumes or supposes. If allowed and encouraged to climb in their own way, they can do wonders.

The lack of sequence, of step by step progression, is a serious fault most prevalent in class-room work, particularly in nature study, in which, more than in most other studies, the teacher is usually left to plan her own work and determine her own order. In the writer's experience with teachers, he has found it helpful, in overcoming this fault, to have the teachers, in planning and conducting their work, divide each lesson into two or more distinctly marked steps, and to have each step carefully reviewed and summarized by two or more pupils before passing to the next step. A lesson on the movements of the canary-bird may thus be divided into: step 1, position at rest; step 2, perching; step 3, hopping; step 4, swinging; step 5, flying. The teacher should get all that she can from the observations of the children about the position of the bird at rest, perhaps supplement this from her own observations, and have it gathered up or summarized by two or three pupils before asking them or even allowing them to tell about the perching of the canary. If such a plan is followed, the children soon learn to observe in some order, and are much more apt to be orderly in their oral and written expression.

In Chapter II this step by step progression and summarizing is frequently illustrated.

A third precaution necessary to insure sequence or continuity of thought is the avoidance of digressions. When the teacher has decided on her line of thought, she must be careful about wandering out of the path into the fields on either side. In no other study is the tendency or temptation to do this greater than in nature study. If pupils talk freely, as they should, they are apt to bring in much extraneous matter. It requires tact to keep them to the line of thought without discouraging them from expressing themselves.

The pupils can be more readily kept to the line of thought if told at the beginning of the lesson just what the aim or point of the lesson is. When they are deeply impressed, at the beginning, with the idea that "to-day we will try to discover how the snail-shells are made, and what becomes of them," or, "to-day we want to learn just how Mother Nature provides for the scattering of the dandelion seeds," they are not so apt to wander.

It must be remembered, however, that the thoughtful digressions by the pupils often indicate the line of thought which the children are following, which may be better for them than the line of thought the teacher has mapped out. Remembering that we are often most successful in leading children when we are apparently being led by them, it is frequently wise to follow out these digressions, when they are sincere and thoughtful, and see where they will take us.

In studying about the elm-tree, for instance; if the children persist in talking about the oriole's nest they found in the elm-tree near the school, the wise teacher may let them tell about the nest, — how and where it is fastened, how deep it is, — and may help the pupils to see that the birds understand, even better than the children, how flexible and tough the branches of the elm are, and how well fitted to support just such nests. The interest in the nest will help to fix these distinctive characteristics of the elm twigs.

Closely related to the avoidance of thoughtless digressions is the importance of "guarding the switches." There are certain points where pupils are most apt to get confused or wander off. These must be guarded with special care. Two "switches" which require special "guards" result from the tendency to depend on old ideas established in the mind, rather than on what the senses tell, and from the tendency to make too broad generalizations. After studying the cricket or grasshopper (see Fig. 27, p. 229) and other insects, and having the idea impressed upon them that these animals have distinct head, thorax, and abdomen, nine children out of ten will think of and draw the crayfish or spider (see Figs. 22 and 23), when they begin to study them, as having a distinct head, although their eyes tell them that head and thorax are very closely united, without any neck. After studying the dandelion and thistle flowers as typical of the composites, nearly all pupils will assume that all compound flowers, such as the clover, are composites. The experienced teacher, who has been over the ground and located these "switches," will have the foresight to warn the pupils before they reach these points.

A common method of keeping children to a definite line of thought is the Socratic method, or development method. By a series of skilful, well-related questions the child is led to see and to state just what the teacher wishes him to see and state.

This development method is often invaluable. In leading children to an abstraction or general truth, such as a rule in mathematics or grammar, or a grouping or classification in botany or zoölogy, or in helping the pupil to see relations which he can never work out for or by himself (as the fact that a potato is a modified stem, and that a thorn may be a modified leaf), it is most effective and necessary.

But in most science work the development method must be used cautiously. Close questioning has less place, probably, in science or nature study than in any other line of school-work, because in nature study pupils have concrete things to work with. Too much development work may be more harmful in science than in any other field. Every experiment and observation is, in general, a question asked of nature; and the answer to that question is usually in plain sight of the pupil who will use eyes and head. When the teacher has made sure that the pupil understands the question, the point of an experiment, the appearance of the leaf in his hand, and has the means for answering that question, it is better to give him opportunity to observe and think for himself, not to distract his attention and interfere with close observation by throwing questions at him.

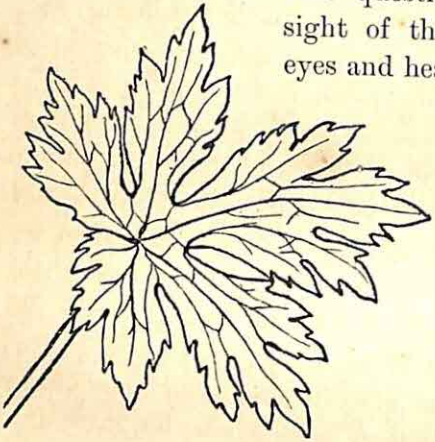


Fig. 21.

The teacher may get from the children a good orderly description of the buttercup leaf (see Fig. 21) by asking such a series of questions as: What kind of a stem has it? How long? What is its shape? What is the shape of the broad part or blade of the leaf? How long? How wide? Where widest? What is its color?

Is the color of the upper and lower surfaces similar? How are its veins arranged? How far out into the lobes do they extend? What kind of a margin does the leaf have? How many main parts? What kind of a base? But from such work pupils get little training in real connected observation and description, and no training in connected thinking. If they are really observing their leaves, they cannot listen to the constant string of questions; if they listen to the questions, they cannot observe. They cannot relate successive ideas about the leaf — and the essence of thinking is thus relating ideas for ourselves — because the teacher does all of the relating, such as it is, and drags her pupils with her. We cannot train children to observe and think by such a process any more successfully than we can teach babies to walk by carefully lifting their little feet one after the other, and pressing each down at the proper distance in front of the other.

To train the boys and girls in connected, related observation and description, it is much better, with the buttercup leaves in the hands of all the children, to ask one pupil to tell all that he can about his leaf, have a second and perhaps a third tell all about his own leaf, noting any differences or errors of observation or of statement, and adding as many new points as possible, and then have the class correct and complete the description. In beginning such work, it may be wise or necessary to have the pupils discover the features to be observed, and then, under the guidance of the teacher, arrange these in order, and formulate a plan for description. Even more helpful in insuring individual connected observation may be a drawing, each pupil drawing, as exactly as possible, his own leaf. After such a drawing they will describe much better.

In the experience of the writer, scores of lessons in nature study have been spoiled, even when the teacher had her work well planned, and was well prepared, had excellent and abundant material, and wide-awake, observant pupils, by such questioning, making it impossible for the pupils to really observe or think for themselves.

In such a comparison as that between the dandelion and thistle suggested in Chapter I, the teacher may lead the pupils to make a clear, orderly comparison by asking a series of questions bringing out in order, point by point, the features in which the dandelion and thistle blossoms are similar. But after the pupils have carefully studied and have understood the flower of one of these plants, it is better for them to discover for themselves as many points of resemblance as they can, even though the work may not be quite so orderly. When they have noted all that they can, then the teacher can ask questions to bring out features unnoticed before, and can lead them to an orderly comparison.

In abstract work, as when leading pupils from many particulars to the demonstration of a rule or general principle in mathematics or grammar, or when gaining a definition in geography, close questioning may be most helpful, even absolutely necessary. In generalizations in science, as in classifying animals and plants, or leading pupils to distinguish characteristics essential in classification from those which are of minor importance, development work is invaluable. Care is necessary, however. Too often the questioning is so done that the child is shut in between two walls, as it were, compelled to go where the teacher wishes him to go by being led to bump his head, first against one wall and then against the other. He has followed a line of thought, it is true, but not his; he has not made it his own. He has simply bumped along, driven by or between the questions of the teacher.

This excessive use of questions illustrates an abuse, rather than a proper use, of the development method. But it is much too prevalent.

In general, the fewer and broader, and at the same time the clearer and sharper, the questions, the better the results, in getting pupils to think for themselves.

The teacher who leads her pupils to relate their ideas for themselves, to follow out a line of thought for themselves, will be much more successful in impressing ideas, and in developing the power and habit of logical thinking, than the teacher who compels her pupils to follow closely her own line of thought.

The next law which must determine method is the law of unity, — an expression for the tendency of the mind to relate and group and unify all its ideas.

In apperception, the combining of new percepts with the concepts already in the mind, we have the first step of the mind in the process of unifying. Sequence, the uniting of ideas in a series, illustrates an extension of this unifying process. The mind strives to continue indefinitely this process of unifying, or relating its knowledge or the phenomena about it, as when it refers many effects to one cause, or groups in one order or class, because of similarity in plan, great numbers of plants or animals.

The child is educated in proportion as he can and does relate the ideas gained; that is, in proportion as he recognizes in his environment, and realizes in himself, unity. The study of physical phenomena is of very little value, comparatively, unless the child can, to some extent, explain them and refer them to their causes. What he learns about plants and animals is almost useless unless he recognizes, and in some degree realizes, their relations and their unity. The facts of history amount to very little unless the child relates them, understands more or less of their causes, and appreciates to some extent the working out of principles or laws.

In the ultimate analysis all the aims of nature study which have been enumerated are, from a psychological standpoint, manifestations or resultants of this unifying tendency of the mind. The awakening of interest and sympathy, the cultivation of the æsthetic, ethical, and spiritual nature, the development of power, and the acquisition of knowledge, are all means or processes of establishing unity in the mind.

We have agreed in Chapter IV that the final aim of nature study or of education in general is to perfect the relations between the child and his environment, physical, intellectual, and spiritual. We want our child to appreciate what he receives from, and to realize and perform what he owes to, his environment, — nature, man, God. Thus can he be adapted to his environment. In formulating this aim, without any discussion of psychological laws, we naturally emphasized environment rather than the child, and dwelt on adaptation to environment. When we look at the question from a psychological standpoint, ask what is the ultimate aim of the mind, we find that the mind ever seeks to reduce to unity all its environment and itself, or to adapt its environment to itself. It discovers that phenomena at first very diverse are illustrations of the same principle, results of the action of the same agency or force; that animals, such as the vertebrates, at first showing almost infinite diversity, are built on the same plan. Thus it refers all physical changes to a few agencies or forces, and groups all forms of life about a few types. The mind finds that physical phenomena and laws are analogous or identical with those of the intellectual and spiritual world. Thus it reduces to unity what is without itself, and then relates this to itself. We see, therefore, in this law of unity, the psychological warrant for the final aim of nature study or of education, before established on ethical grounds, the perfecting of the relations between the child and his environment, or the reducing to unity of the "I" and the "not I."

We express the same idea in spiritual terms when we say, with the Great Teacher, "Love is the fulfilling of the law." Love is unity. Recognizing the unifying tendency of the mind, and the importance of developing it, we see why interest and sympathy are so essential. They are the only means of establishing the greatest unity between the child and his environment.

In the law of unity we find the psychological basis for the greater educational value of the study of life, the most nearly perfect illustration or realization of physical unity. In a living plant or animal all parts are organized to co-operate with one another, to work as a unit in taking from environment, — from sunlight and soil and air, — and in giving to environment. Perfect physical life in plant or animal is perfect adaptation or perfect relation or complete physical unity between it and its environment, or that part of its environment to which it is adapted or related. As this unity becomes less complete, disease comes. When death ensues, unity ceases. The plant or animal is no longer a unit, but is disorganized, made up of isolated parts. In the study of death, of mere form and structure, the child does not see this unity, and his mind is not greatly aided in its unifying process. In the study of leaves or roots or stems or flowers, isolated and not related to the plant, this psychological demand for unity is not recognized nor satisfied.

From this standpoint we see also the psychological reason for emphasizing the study, in earlier years or lower grades, of life and living nature, and of forces and processes, and understand why the study of minerals or of mere form and structure is not so interesting to young children, and not so satisfactory in its results. If in earlier years children can study units, — the whole living plant, its development from seed to maturity, and growth or adaptation to environment; and living animals, caterpillars and butterflies, frogs' eggs, tadpoles and frogs, living birds or kittens or fish, — they learn to relate parts to wholes, to recognize the unity between plant or animal and its environment; and thus the unifying tendency of the mind is recognized and developed. After such preliminary work the mind more readily, and oftentimes necessarily or automatically, unifies what is not presented to it as units; relates the leaves or flowers to the plant, thinks of them, not as mere forms, but as parts of a whole, depending on and working for the whole plant.

The child who has studied the life of the dandelion, the development and work of root and leaves and flowers, the ripening of seeds, and the preparation and arrangement for their dissemination, the co-operation of plant and wind in scattering the seeds, who has compared the life and adaptations of the dandelion with those of two or three similar plants having similar adaptations, is much better prepared to unify or reduce to unity, and therefore much better educated, than the child who has simply described the form and gross structure of fifty isolated leaves or of a score of roots or flowers, or has dissected or analyzed and grouped by mere structural or morphological features a dozen plants.

In the same law of unity we see the reason for the greater educational value of the questions "why" and "how" as compared with "what." "What" is mere structure, and is isolated. "Why" and "how" relate the structure and thus help to unify. We may describe the form and structure, the "what," of the dandelion, and never think of it as related to anything else. When we ask "why" and "how," we begin to relate it to its environment. Why is it colored? To attract insects, to beautify the world. Why does it have the green cup, or involucre? To protect it from moisture, from sudden changes, or from insects. Why do the florets have hairs (the pappus) about the base? To catch the wind, and aid in scattering the seeds. Each "why" suggests a new relation, leads to a better realization of the co-operation and unity of nature.

How does the recognition of this unifying tendency in the mind, and of the importance of unity in the work, affect or determine the method of study?

First. We must endeavor to impress the idea of unity in the child's physical environment, nature.

Second. We must labor to make more complete his realization of the unity between his physical and intellectual environment, nature and man.

Third. We must strive to lead from nature and man to God; to impress deeply on the child the unity of all parts of his environment, physical, intellectual, spiritual.

Fourth (and including the others). We must do all in our power to bring the child into the closest relations with all his environment, into unity with nature, man, and God.

How can we impress on the child the idea of unity in his physical environment; that is, in the world of nature about him?

At first, perhaps, everything is unity to the babe. He has little power of analyzing. He soon, however, begins to separate his environment from himself, the "not I" from the "I." In time he distinguishes different parts of his environment, — mother, nurse, father, food. At first he doubtless sees a pussy as a whole, with little or no conscious analysis. Later he distinguishes head and body and tail and legs, and gradually minor divisions. This process of analysis, of separating into and distinguishing parts, is continued as he develops.

The problem at first is, not to *give* the child the idea of unity, but to *keep* that idea in his mind as and while he analyzes.

The development of the analyzing power in the race has been similar. The progress of knowledge has gradually compelled man to separate what was once called natural history, into many distinct sciences, — botany, zoölogy, chemistry, physics, each with a host of subdivisions. These distinct sciences, as such, have little place in work with young children. They must study nature much as their ancestors studied nature before these sciences existed, and as the children study nature before they enter school. This does not mean that they are merely to flit about and sip here and there, but that each thing studied may, and often should, become a centre for the study of much about it.

When we thus study the dandelion in its relations, investigate the co-operation of its parts, and their relations to their environment, — soil, wind, sun, insects, — we are brought into contact with a large part of nature, and study portions of many sciences. The absorption of water and food by the roots leads us into physics, capillarity, and osmosis, though we may not use these terms. The transformation of this absorbed matter into "milk" is a chemical process, although the children may never hear the word chemical. Any observation or study of the insect visitors of the dandelion and of their work leads us into zoölogy.

We can emphasize the unity in our physical environment by studying plants and animals as units, and by studying the phenomena of nature in their relations. These relations have been enumerated in Chapter III.

These relations, so far as they need to be considered here, can be gathered into two general classes, relations of dependence (including causal relations), and relations of similarity and difference; the first functional, the second structural. As brought out in Chapter I, the dandelion has relations of dependence upon soil, air, wind, and water (rain, dew, clouds, frost, snow), sun, animals, and man; that is, these help or harm it, or are helped or harmed by it. It has a relation of similarity or difference to other plants (more particularly composites), more remotely to animals, most remotely to inorganic nature. It is like or unlike these in form, structure, or plan.

Which of these relations is most important? In the science of the past, as pursued in most educational institutions, and particularly in the study of botany and zoölogy in secondary schools, all emphasis has been placed on the relations of similarity and difference; and, as a result, great prominence has been given to comparison of form and structure, and to classification. It has apparently been assumed, oftentimes or usually, that comparison of form and structure, and classification based on these, were almost the only method or means of unifying or reducing to unity this part of our physical environment. On the contrary, it is the functional relations which show the most complete unity. The structural relations are but the preparation for or result of functional relations. The similarity in plan, form, color, etc., depends on similarity in function or work.

If it is true, as has been asserted in previous pages, that the study of life and function is of greater educational value, at least in elementary schools, than the study of structure, then the functional relations, those of dependence, are more important than relations of similarity and difference in structure. While great emphasis must be placed on these functional relations in work with young children, as they grow older, more and more attention can and should be given to form and structure, and to structural relations.

The recognition of this principle will greatly influence the method in nature study in elementary schools. In accordance with this principle, children should begin their plant study with whole plants, and study these first in their functional relations. They can begin in the first and second grade (see Course of Study, Chapter XV) with the study of such a plant as the mallow, or with the growth from seed to maturity of the bean or pea, and have impressed the mutual dependence of all parts, — roots, stems, leaves, flowers, fruit; the dependence of the plant on soil, water, sun, and man; the dependence of man and animals on the plant; the dependence of all on the Creator. The form and structure of parts should be studied as adaptations to work. The comparisons should be at first a comparison of the ways in which the organs do their work, preparing for a comparison, later, of the ways in which they are fitted for their work; that is, for a comparison of form and structure, resulting in classification.

The children, young or old, should never begin their study of leaves by merely comparing their forms and veining and arrangement on the stem. In their study of the development of seeds and buds, the children should first have impressed the idea of the leaf as something related to the whole plant, formed by and developing from the plant (from seed or bud), dependent on the plant, working for the plant. Gradually other functional relations can be brought out. As the child begins to understand these functional relations he can begin to appreciate the arrangements the leaves have for doing their work. The veins will then be, not merely veins, but a framework to hold out to sun and rain, or channels and tubes to carry water. Their arrangement may then have a meaning. Later, in the third or fourth year, more attention can be given to the comparison of the forms of leaves; that is, to the formal study of relations of similarity and difference, connecting these, however, with function. This will prepare for comparison and classification, and the study of families and larger groups in the upper grades.

It is evident that it is neither wise nor possible to dwell on all the relations of everything studied. It becomes essential to select that material which will best illustrate these relations, and to which other material, not so carefully studied, can be related, or about which it can be grouped. The chapters on selection of material and formulation of courses of study (Chapters XIV and XV) indicate the material which will best serve as centres for work in the different grades, and, at the same time, serve as foundations for later work.

How can we, in and by our methods in nature study, make more complete the unity between the physical and intellectual environment of the child?

Certainly not by separating the physical and intellectual as far as possible, that is by divorcing nature and all school-work as we have done in the past. Rather by uniting these as closely as possible, basing much of the school-work on nature study. The better the child realizes that school is out-of-doors as well as in the schoolroom, in plant and animal and stone, in cloud and sunset and waterfall, as well as in book, the more complete will be the unity between his physical and intellectual world. The more his nature study is correlated with and made a basis for his language work, drawing, reading, and literature, the more will the unifying tendency of the mind be satisfied.

The child and the poet see in the physical world much that symbolizes man and God. This symbolism of nature, rightly impressed and re-enforced by literature, will do much in leading to unity.

The methods of relating nature study to other schoolwork are discussed in Chapters XI, XII, and XIII.

How can we best impress on the child the unity of all his environment, of nature, man, and God? Not by mere preaching. Rather by leading him sympathetically, reverently, where he can read for himself the "one great loving thought written in hieroglyphs of bud and bloom." By taking the child to bud and leaf and flower, to nest and egg, where he can *see* for himself the lessons of protection and care, shown alike in the physical, intellectual, and spiritual, by nature, man, and God. By letting him absorb, day by day, week by week, year by year, naturally, and often unconsciously, the lessons of mutual dependence and mutual helpfulness, the lessons of slow but sure development, the lessons of patient waiting and preparation. By impressing the lessons of purpose and order and plan all about him, and thus leading to the Protector and Thinker and Planner and Director, the highest Unity.

How can we bring the child into closest unity with all his environment? The question has already been largely answered in Chapter IV. Only sympathy and love can bring unity. Love is the fulfilling of the law — of all law. The teacher who has led her pupils to regard nature reverently and sympathetically has done much to bring into unity the child and all his environment.

THE PRIMROSE ON THE ROCK.

A rock there is whose homely front
The passing traveller slights;
Yet there the glow-worms hang their lamps,
Like stars, at various heights:
And one coy primrose to that rock
The vernal breeze invites.

What hideous warfare hath been waged,
What kingdoms overthrown,
Since first I spied that primrose tuft
And marked it for my own;
A lasting link in Nature's chain
From highest heaven let down!

The flowers, still faithful to the stems,
Their fellowship renew;
The stems are faithful to the root,
That worketh out of view;
And to the rock the root adheres
In every fibre true.

Close clings to earth the living rock,
Though threatening still to fall;
The earth is constant to her sphere,
And God upholds them all:
So blooms this lowly plant, nor dreads
Her annual funeral.

WORDSWORTH.

What has been said heretofore about the characteristics or laws of the human mind applies to the child as an individual. The child or man alone on an island, shut off from all intercourse with his fellow-men, would be dependent on his senses for new percepts; would assimilate these by the process of apperception; would be most impressed by that in which he was most interested; would try to picture or imagine what he could not see by modifying and combining what he had seen; would combine his ideas, to a greater or less extent, in a series or sequence; and would endeavor, with more or less perseverance and success, to unify his knowledge. His development would be much retarded and limited, however, by the fact that he could not exchange ideas with others, convey his ideas to others, and receive their ideas in return. Man is a social being, and must not merely get and unify ideas, but must impart and exchange ideas.

This brings us to the consideration of expression, the process or means by which ideas are conveyed to or received from other minds. By expression is meant not merely language, but any means of conveying or expressing ideas, — drawing, painting, moulding, sewing, music, gesture.

Expression has a threefold object or function:—

First. To clarify, make more clear and orderly, our ideas, by bringing them into consciousness, arranging them in order to be conveyed to others, and forcing us to recognize our own weaknesses, either in perceiving or relating facts. Expression, the attempt to convey our ideas to others, leads us to relate our knowledge, and put it in order much as an expected visitor leads the housekeeper to "put her house to rights." Teachers recognize this fact when they say, "We do not know what we know until we try to teach it."

Second. To convey ideas to others, and thus aid us in influencing others, or in adapting other minds to our mind. Assuming that we have ideas worth expressing, gained by and through the means already considered, we will be most successful in bringing others to our way of thinking, adapting this part of our environment to ourselves, in proportion as we can most effectively express our ideas.

Third. To give us a medium through which we can receive ideas from others, and thereby relate or adapt our mind to other minds. In general, the better we can express our own ideas, the better will we understand the ideas expressed by others.

The relation of nature study to the expressive work of the elementary school is considered in Chapter XI.

CHAPTER IX.

THE ORDER AND METHOD OF STUDYING MATERIAL.

HAVING discussed the principles which must determine method, we are ready to consider the general order of study, the first step in the application of these principles.

The value of the study by children of the relation of plants and animals to their natural environment, and of the study of life and habits, has been illustrated in Chapters I and II, and discussed in Chapter VIII. In Chapter II, on the study of the rabbit, were illustrated some of the advantages of beginning with home and habits, followed by the study of structure, comparison, and classification. The order will be largely determined by aim and the necessity of basing work on sense-perception and apperception. Emphasizing the higher aims, we begin with home, life, and habits, if they can be observed. If the conditions are such, as in study of starfish inland, that life and habits cannot be observed by pupils, then it is often better to begin with structure, that is, with what can be seen. The reasons for following the order below are further discussed in connection with the different steps.

In considering method we must give some attention to each of the following steps in presenting matter: —

1. Name.
2. Relation to natural environment.
3. Habits or function (and life history (?)).
4. Structure (and life history (?)).
5. Comparison and classification, or association and generalization.
6. Application.

The first essential in studying anything is the name; the child should know what he is studying. A name which means nothing, is not based upon or does not suggest any concept or idea, is very difficult to relate or apperceive, and difficult therefore to remember. Whenever possible, the name should be related with an idea, with something which suggests the name, or from which the name originated. It is best to relate the name with something which the child can see. When the child has learned that aster means star, the starlike appearance of the flower will suggest the name. The names starfish, sunfish, trillium (triple or three, having parts in threes, sometimes called "trinity flower"), pyrite (firestone), milkweed, earthworm, bloodroot, Solomon's seal, painted cup, and a host of others, will be much more readily apperceived and recalled or remembered if the meaning of the name is explained to and impressed on the children.

Of course with children we will use the common names, when there are any, not the technical names.

Harebell, buttercup, butter-and-eggs, sea-anemone, and earthworm mean much more, are more readily apperceived and remembered, and are much better for children, than their technical equivalents, *campanula rotundifolia*, *ranunculus*, *linaria vulgaris*, *actinia*, and *lumbricus*.

Frequently the name can be associated with some beautiful legend or story: trillium with the legend of the trinity flower; hyacinth with the old Greek legend of the boy friend of Apollo; narcissus with many old stories. The name may suggest a comparison or simile, the name iris suggesting the rainbow; the Jack-in-the-pulpit always attracts the little folks because of the idea associated with its name.

Having provided that the pupils shall not merely hear the name, but if possible shall be interested in it, apperceive it clearly or associate it with an idea, and make it the beginning of a sequence, what is the next step, the first step in the study of that part of nature which we have named? If we wish to unify the child's ideas, we should first relate the thing studied to the whole of which it is part. We are studying it in the schoolroom; it does not belong there. The next step should be to relate it to its natural environment. Is it a mouse, bird, insect, fish, a plant, a whole in itself? Where was it found? Under what conditions? What are its relations to earth and sun and rain and plants and animals? If an animal, what about its home and home-life and habits? If a plant, how does it develop; in what kind of soil does it grow; do its leaves or flowers turn toward or follow the sun; do its flowers close at night; is it the home of any animals, caterpillars, insects, birds? Is it a leaf or flower or root or branch, or feather or shell, a part of something? To what did it belong? Of what was it a part? Where did it come from?

In the case of minerals, the relation to environment is not so intimate or evident, and therefore not so important or essential, as in animals and plants. Forces, studied in physics and in chemistry, have no environment; they are everywhere. But minerals and rocks can be considered as earth materials, and physical forces as earth forces. Particularly in earlier years, it is helpful thus to relate them very closely to the earth (and to geography), quartz and sandstone becoming the most abundant materials out of which Mother Nature has built the crust of the earth, and heat the force which she uses to change the earth's crust. Later, with mature pupils, minerals and rocks may be unified by grouping them according to their chemical composition, and forces related through the law of gravity or the law of conservation of energy.

By thus always relating all things studied to nature, to their natural environment, rather than studying them as isolated leaves or stones or snails in the schoolroom, unrelated to nature, we help the child to start his study with something akin to unity. The different things studied are brought together again in a subsequent step, comparison and classification, or generalization, and are thus more or less unified at the beginning and at the end.

Remembering that the best foundation is sense-perception, actual seeing, by far the best way to relate to environment is to take the children out for a field lesson, to see grasshopper or cricket or caterpillar or ant or snail in its natural home; to see where and how buttercup and mallow and fern and elm grow; to gather the stones, and study the position and arrangement of rocks, and watch the work of rain and streams. A field lesson with a definite aim and definite work for each pupil, carefully planned, well conducted, well followed up afterwards and clinched, is, in general, worth half a dozen schoolroom lessons.

The higher value of out-of-door study of nature Emerson has expressed in his poem "Each and All": —

> I thought the sparrow's note from heaven,
> Singing at dawn on the alder bough;
> I brought him home, in his nest, at even;
> He sings the song, but it cheers not now,
> For I did not bring home the river and sky; —
> He sang to my ear, — they sang to my eye.
> The delicate shells lay on the shore;
> The bubbles of the latest wave
> Fresh pearls to their enamel gave,
> And the bellowing of the savage sea
> Greeted their safe escape to me.
> I wiped away the weeds and foam,
> I fetched my sea-born treasures home;
> But the poor, unsightly, noisome things
> Had left their beauty on the shore
> With the sun and the sand and the wild uproar.
>
> . . . .
>
> Then I said, "I covet truth;
> Beauty is unripe childhood's cheat;

I leave it behind with the games of youth:"—
As I spoke, beneath my feet
The ground-pine curled its pretty wreath,
Running over the club-moss burrs;
I inhaled the violet's breath;
Around me stood the oaks and firs;
Pine-cones and acorns lay on the ground;
Over me soared the eternal sky,
Full of light and of deity;
Again I saw, again I heard,
The rolling river, the morning bird;—
Beauty through my senses stole;
I yielded myself to the perfect whole.

The manner of conducting field lessons must be determined mainly by the aim and the conditions in such out-of-door work. The aim is to get in touch or harmony or unity with nature; to investigate the relation to natural environment of that bit of nature in which teacher and children are specially interested; to gain or study what cannot be studied or acquired in the schoolroom. The conditions are very different from those prevailing in the school. The pupils are at home, where they realize their natural privileges and rights, and where the teacher often has to become the pupil. They are more free, more natural, more difficult to restrain or control, or at least less amenable to schoolroom rules or methods of discipline. The surroundings attract and distract the pupils. There is so much about them, that it is much more difficult to gain their attention, keep them at work, or pin them down to special, definite work.

Nothing is more helpful in giving direction to an out-of-door lesson, in imbuing the children with the spirit of nature, than an introductory literary gem, or a short story. Parts of Bryant's "Forest Hymn" read as they have gathered under the trees may make a deeper impression than hours given to its study in school. Longfellow's "Autumn," or portions of Lowell's "Indian Summer Reverie," or "The Maple," may be the best prelude to the study in the meadows or park of the autumn leaves, may impress the thought of the perfect whole, the highest aim of the field lesson.

The purpose of the field lesson, it must be remembered, is to study, not mere form and structure, but processes and relations, life and dependence on and adaptation to environment. Structure can be studied better in the schoolroom, where the conditions are more favorable for definite work. In our work out-of-doors we should largely limit ourselves to what cannot be observed or cannot be studied as well indoors; such topics as the falling and coloring of leaves, the work of earthworms or frost, of rain or streams or waves, the formation of soil, the relation of leaves and flowers to the sun, the habits and homes of insects, birds, and other animals, the occurrence, form, color and other obvious characteristics of trees.

It is difficult, unnecessary, and unwise to attempt to maintain out-of-doors the order which is required in the school. Such order will defeat the purpose of the field lesson. On the other hand, a lesson in which no order is maintained, which degenerates into a frolic or picnic, is not merely of little value, but may bring discredit upon all the work in nature study, and tend to postpone the time when this natural method of studying the children's natural environment shall be followed in other subjects, such as local geography and history.

The secret of a successful field lesson is: A definite aim or object understood by each pupil as well as by the teacher, definite work for each pupil, followed by a definite report on and review of what is observed. In a field lesson, with the freedom and lack of restraint, and with distracting surroundings, from which the schoolroom is largely free, definiteness in aim and plan is more important than it is in any other work.

The pupils should have, in the preceding lessons, enough to interest them in what they are to observe out-of-doors, and each pupil should know just what he is to investigate. It is helpful to have several points which all are to investigate and report upon orally, and, in addition, to give each pupil one or more questions upon which he is to report. If the reports can be in writing, so much the better.

After the pupils individually have done all they think they can do alone, with such suggestions here and there as the teacher may be able to give, it is often helpful for the teacher to gather the pupils about her in the field, and correct any serious errors. The definite review or summary will usually be more successful in the schoolroom.

If a field lesson with the class is or seems impossible, the teacher will find it helpful to go out occasionally with a few pupils after school or on Saturday. For the study of many things, such as ants, crickets, mallows, trees, birds, buttercups, stones, earthworms, dissemination of seeds, it may be necessary to go only a few hundred feet from the schoolhouse, even in the heart of a city, and may not require more than half an hour or an hour. A field lesson with the teacher and one pupil in attendance will lead the teacher to look at nature, to some extent, from the standpoint of her pupils, and aid her in adapting herself to her pupils.

Nothing so draws together teacher and pupils, making them fellow-students and fellow-investigators of truth, as well-conducted field lessons, where they are on the same plane, the teacher often becoming a pupil, the pupils, who are so much nearer to nature than their teacher, often becoming teachers.

Much concerning the natural environment or home of what is being studied can usually be drawn from the children. Many or most children have an unsuspected store of nature lore, like Whittier's "Barefoot Boy": —

> "Knowledge never learned of schools,
> Of the wild bee's morning chase,
> Of the wild-flower's time and place,
> Flight of fowl and habitude
> Of the tenants of the wood;
> How the tortoise bears his shell,
> How the woodchuck digs his cell,
> And the ground-mole sinks his well;
> How the robin feeds her young,
> How the oriole's nest is hung;
> Where the whitest lilies blow,
> Where the freshest berries grow,
> Where the groundnut trails its vine,

> Where the wood-grape's clusters shine;
> Of the black wasp's cunning way,
> Mason of his walls of clay,
> And the architectural plans
> Of gray hornet artisans!—
> For, eschewing books and tasks,
> Nature answers all he asks;
> Hand in hand with her he walks,
> Face to face with her he talks,
> Part and parcel of her joy,—
> Blessings on the barefoot boy!"

The poorest student, the boy who takes no interest in his school-work and plays truant whenever he can, may be able to tell most. And here may be the opportunity of the teacher to interest and get a hold on that same bad boy.

If the children cannot relate to natural environment, if they have never seen what they are studying, the starfish or sea-urchin or coral, the cotton or cocoanut, the limestone or iron ore or coal, in its home, or where it naturally occurs, then the teacher may endeavor by picture or blackboard illustration or word picture to give the children some idea of its occurrence.

When the children know nothing about the occurrence of what they are studying, and it is difficult for them to gain any clear idea of it, as in the starfish, it is well to change the order of study, begin with what they can see, the structure of the thing itself. This will give a good foundation for future work; and the study of relation to environment may be taken up later, and more or less incidentally.

All the work heretofore indicated may be considered as preparatory. Now comes the presentation of new matter in the schoolroom. With what shall we begin? Of course we want to build on the foundation laid in the preparatory work. How? By going on with the same line of thought or sequence; studying in the schoolroom habits, work or function, development or formation.

Have the pupils told a little about the habits of the animal they are studying, rabbit, crayfish, cricket, fish, canary, squirrel; not merely where it lives, but how it lives? Continue the study of life and habits by observing these in the schoolroom; how the animal moves, crawls, walks, flies, how and what it eats, how it breathes, how it sleeps. Read about those habits which cannot possibly be observed. Study carefully the use or work or function of the different parts, and the way in which they are used; that is their "why" and "how."

Have the children study in the schoolroom the development and the work of the plant and its parts. They have gathered buds in the early spring, noted the trees from which they came, and their position, and perhaps, arrangement on the branches. Have them put those buds in water, watch their development, discover the function of gummy or hairy covering and scales and stipules, and note, as the parts develop, how they are arranged, and why they are so arranged. Have they learned to recognize the mallow, discovered how well it is anchored in the ground, noted how its leaves face the sun from morning to night, and how its younger leaves and its flower close before dark? Study with them in the schoolroom the function and development of root and stem and leaf and flower (so well shown in the common mallow), the "why" and "how" which shall make them think, lift them up, and prepare them for the later more definite study of structure, the "what."

The pupils have learned where the limestone they have in their hands occurs, and perhaps how it breaks down or crumbles. Work out with the children the story of the formation of the limestone. Its fossils, shells, or corals may serve to connect it with animals of long ago from whose skeletons it was made. Its crystals may give the clew to the process by which it has been deposited from water.

Following the same line of thought, we can begin with the origin or sources of physical forces, heat or electricity, following with a study of their effects, what they do, their work or function.

The study of life history, of the development from seed or egg or larva or babyhood, of plant or animal, and the story of the formation of mineral or rock, may come at this stage, or may be placed later in the order of study. Where the story of life history must be told, it is better to have it after the study of structure. In many cases, as in the crayfish, the children cannot understand the story of development from the egg until they have a fair idea of the structure of the adult. Where development can be watched in the schoolroom, as in the case of caterpillars and butterflies, it may be better to study life history before structure.

Much has been said in previous chapters of the greater educational value, particularly for children, of such investigation of the living, working side of nature, or of the function and story of plants and animals and rocks, as compared with the study of mere form or structure or morphology. It is in accordance with the law of apperception. Life and action are more like the child himself, appeal to him, can be better understood by him. Life and action and work, the story of development and formation, interest the children, and appeal to their sympathies and to their higher nature, because life and function, rather than structure, show the higher side of nature.

The observation of life and function and the study of development and formation lead to the questions "why" and "how," and compel the child to think and to relate what he is learning, and thus tend to unity. Until an animal or plant is studied alive, and as a living thing, with all its parts co-operating, it is not a unit, but a collection or aggregation of parts. When we know the story of a mineral or rock, the forces which have acted on it, and the changes through which it has gone, it becomes almost a thing of life, a connecting link between the past, present, and future.

The study of habit and function and development or formation is the best possible preparation for an understanding of structure. The child who has watched the cat drink milk or eat meat, or climb a tree, or sharpen its claws and draw them into their sheaths, is best fitted to understand the structure of tongue and teeth and claws. The structure will be related to function, each "what" associated with a "why" and "how." The pupil who has watched the development of the bud into the flower, and the formation of fruit and seeds by the flowers, who has seen how the calyx folds about and protects the other parts, how the corolla beautifies, how the pistil becomes the seed-box, who has learned that the corolla attracts insects, and that its markings and hairs guide insects to the nectar, is prepared to study the structure of the flower; in fact, he has been studying structure without knowing it. The structure of sandstone or limestone, its layers or crystals or fossils, is not only better understood when the child has seen how water deposits materials in layers, or watched the formation of crystals of alum or sugar, or learned how shells are deposited in mud and how the mud is hardened into stone, but the child cannot possibly understand their structure until he has learned the story of their formation.

The study of habit and function relates best with literature and art. As has been said before, it is life and function and story which have appealed to the poet and artist. There is scarcely any literature of mere structure.

The investigation of habit and function and development gives the best opportunity for freedom and individuality in observation and expression. Every child in the class may carefully observe the habits of the canary in its cage in the schoolroom, how it hops and walks and perches, how it eats and drinks, how it sings, how it sleeps; and each has a different story to tell, or tells what he has seen in a way different from all the others. When they come to describe the structure of the canary, — its body and head and wings and tail and legs and feet, — all are telling about the same thing, and are apt to tell it in about the same order and words. The latter description will be more exact, but at the same time more stereotyped, less free and individual.

Much of what is here said about the value or content of the study of life and habits, and about the method of observing these, has been brought out concretely and clearly illustrated in the outline or plan for the study of the rabbit in Chapter II.

This study of life and habits in the schoolroom or at home requires time; it cannot be done in a day. The material should be before the pupils for several days, where they can watch it, and occasionally report what they have learned. They may watch the germination of the seeds in their window-boxes, or the development of the buds in the jars, or the movements and habits of the crickets or fish or snails or crayfish, for a week or more before they have a formal lesson. Much of this work will be done before or after school, or at home, if the children are interested. If there are several boxes or jars about the schoolroom, they can watch or study these during school-hours without confusion. The study of relation to environment and habits is of little value unless based largely on personal observation by the children. Without this it degenerates into mere guessing, which is worse than nothing — is not only useless, but injurious.

The teacher may help or guide them by occasional definite questions, perhaps one or two a day, written on a corner of the blackboard; such questions as, "Find out exactly how the caterpillar eats and what it has to eat with," or "How does the caterpillar crawl?" "With how many legs?" "Does it use them all in the same way?"

To lead each pupil to observe for himself, it may be well to urge the pupils not to tell others what they have observed. Sometimes it is helpful to have each one write an account of his observations, of what he himself has learned, before there is any class recitation.

The order in studying habits and function of plants or animals is not material. We should begin with those most easily observed and leave to the last those most difficult for the pupils to see. In gathering up the observations in the class or in writing, however, all that has been learned about any one topic, as eating, moving, or breathing, should be brought out or told before passing to a new topic.

Here, in connection with the life and function, is the place to bring in the literature. The literature, if well selected, and the study of life, react on each other most helpfully at this point.

CHAPTER X.

THE ORDER AND METHOD OF STUDYING MATERIAL (CONTINUED.)

THE next step in the presentation of matter in the schoolroom is the study of structure, — that in the plant or animal which adapts it to its environment and fits it for its work or function; and that in the rock which is the result of the action of the agencies by which it was formed.

While much of structure is studied in connection with previous work, it is studied incidentally. At this stage structure must be emphasized both as a means of reviewing and clinching and unifying or binding together what has been learned about habit and function and story, and as a basis for a subsequent step in the process of unification; that is, comparison and generalization, or classification. After the child has learned the work or function of the dandelion root, has discovered how firmly it holds the plant in the ground, has seen its store of "milk" and noticed the disappearance of the "milk" and the shrivelling of the root as the seeds ripen, has learned that the rootlets take up water, and food dissolved in the water, then he is not only prepared to study the form and structure of the root, but such study will review and clinch and bind together what he has learned about function. The long, conical, tough main root suggests its function, — to hold fast. The thickened, upper part is fitted for its work as a storehouse, until the storehouse is no longer needed. The fibrous branches have a work, — to absorb water and food from the soil. It is more than a fleshy, conical tap-root, as the botanist would describe it; it is a holdfast, a storehouse, an absorbent. Moreover, this same root may in the next step become a type of roots which have similar functions, and thus become a means of still further unifying the student's ideas.

The relation between the study of habit and of structure and many of the principles and ideas discussed in this chapter have been applied and illustrated in the outline for the study of the rabbit in Chapter II.

The study of habits and function is largely a process of analysis. If we stop with the study of the habits of the canary-bird, we have little idea of the bird as a structural whole or unit. The study of adaptation to function or of structure is largely a process of synthesis, of bringing together and reducing to unity what has been separated in the previous step.

If the study of structure is to be a means of reviewing and clinching function, and is to lead the child to think, we must constantly ask "why" and "how." What is the use of this? Why is this so? It is not enough to say that the grasshopper has very large hind legs. Why? It has a groove on each side of the abdomen. Why? To aid in breathing. How? But the "why" should not be asked until pupils have gained clear definite knowledge of the facts necessary to answer the question. Mere guessing at "why" is worse than useless.

If the study of structure is to prepare for comparison and classification, we must particularly emphasize those structural features which are most important in classification, — the peculiarities of the flowers and florets in the dandelion and of the teeth in the rabbit.

With younger pupils in the first or second grade of the school, for whom structure has little meaning or interest, and whose power of relating or unifying structural features is but slightly developed, the study may stop with the observation of function and story, the growth of plants and habits of animals, and what structure may naturally be brought out in connection with these. As the children grow older, structure becomes more and more important as a means of reviewing function and preparing for generalization; as a step in the sequence by which they should relate their ideas, reduce them to unity, or to some approach to unity.

The question often arises, "How far is it wise to take up with the children details of structure or properties obscure or difficult to understand?" In general, in the work with children of any grade, only those features of structure or those properties should be studied or emphasized which either throw light on function (including use to man) or aid in comparison and classification, so far as the children of that grade study or can understand these. For instance, in the study of the mineral mica (commonly but incorrectly called isinglass), its softness (easily scratched with the finger-nail), lustre (the brilliant shine of its surface), cleavage (the property by virtue of which it breaks into very thin plates), elasticity, transparency, and infusibility are the properties which make it useful and distinguish it from other minerals. It has many other properties, mineralogical and chemical, which the child need not study at all, or may merely note without attempting to remember them. The youngest children can discover the function of the little hairs at the base of each little dandelion flower, or floret (the pappus), can see how they aid in disseminating the seed. Therefore they should note the presence and appearance of these hairs. The young children cannot understand the real function of the stamens, so it is not necessary nor wise, in this flower, where they are so indistinct, to ask the little folks to study the stamens.

"How far is it necessary or wise to dissect animals?" is a question often asked. Teachers dread dissection. A similiar question which might be asked with equal propriety, but which is not often considered, is, "How far is it necessary or wise to allow or encourage the pupils to tear into pieces plants?" The higher aim of nature study — that is, to develop a sympathy and love for nature, and particularly for life — must determine this. There should be very little study of dead animals during the first three or four years, and no dissection of any kind during the first five or six years. During the last two or possibly three years, particularly during the last year, some dissection may be wise, but should usually be done by the teacher. Animals which are domesticated or are pets, such as kittens, should never be dissected before, or for, or by the children.

During the first two or three years children should never be allowed to pull to pieces plants or flowers. In later grades they should do no more of this than is absolutely necessary. They should learn to reverence life, plant or animal.

Closely related is the question as to the advisability of using microscope or magnifying-glasses. Nature study should lead the child to study the world about him, and to use the instrument he has, — his own eyes. Compound microscopes open a new world. While they add to the interest and gratify curiosity, while they are helpful in studying pollen grains and butterfly scales, and the compound eyes of insects and the breathing-pores of leaves, they are not necessary for work with children, and give them little of much educational value. Children do not understand much of what they see in a compound microscope with a high magnifying power, partly because they do not relate it to what they see with their unaided eyes, partly because such a microscope shows at any adjustment only a section of an object in the plane which is in focus, and they do not relate the different planes seen at different adjustments. Simple microscopes are helpful in work with pupils in the upper grades in bringing out details of structure. They should be used very sparingly and carefully with young children, as they are apt to strain the eyes.

If the study of structure is to be most effective in producing a clear mental picture in which or to which parts and functions are related, it must be orderly. In previous steps there should be an order or sequence, but conditions must largely determine that order. In studying or describing form or structure the order must be determined by the order followed by the mind in making a mind picture of form or structure. We appreciate and realize best the process in making a mental picture when we attempt to draw from a description what we do not see, — a spider, for instance (see Fig. 22). If, as we stand before our pupils ready to make on the blackboard a picture of the spider from their description, we are told first that the spider has eight legs, or that it has several eyes, or that it has a pair of feelers (palps) in front of its head, we cannot draw, we cannot place the legs or eyes or feelers, or relate them to the whole spider. They must tell us first about the spider as a whole, and about its body, the part to which legs and

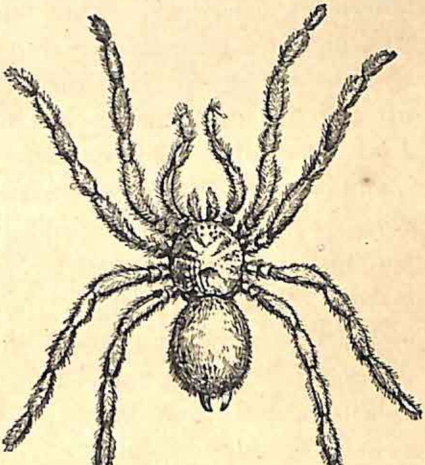


Fig. 22. Spider.

eyes and palps must be related. If we are told that its body is an inch long, we can lay off that distance, or some multiple of it, on the blackboard. Next they might tell that it is about one-third as wide as long, rounded at the sides (oblong, some might say), divided by a neck into two parts, the first a little shorter than the second, both a little longer than wide, rounding toward either end. From such a description we might get a fair mental picture, and make a fair drawing, though we had never seen the spider. Now we want to add the appendages or other parts. It does not help us even now to be told that the spider has eight legs. We cannot relate them to the body. Where are they attached? we ask. Four fastened on each side of the first division of the body, the first pair back a little from the front end. Now we can place them in our drawing. If next they began to tell about the ends of the legs, we would be at a loss again. The bases of the legs are in place; the ends have not been related to the base, are off in space. First we must get some idea of the legs as a whole. They are long (an inch long), slender, the first two pairs projecting outward and forward, the last two backward. They taper toward the outer end, and have several (seven) joints. Now we can get and make a picture. When told, not merely that the spider has several eyes, but that the eyes are near the front of the upper surface of the first division, and are arranged in two rows running across, with four eyes in each row, we can draw without difficulty.

This will serve to illustrate the importance of the following rules, which will greatly help us in unifying our ideas of form or structure, and in gaining and conveying to others good mental pictures of form. As minerals are distinguished by their mineralogical and chemical properties rather than by their forms, these rules have little application in the study of minerals and rocks.

First. Study and describe the whole before taking up its divisions, the central or main part before considering appendages.

Second. In studying and describing parts or appendages, first relate them to the whole.

Another rule may be added, not so widely applicable, but helpful in insuring logical order or sequence. It will also prevent a useless waste of material, so common when pupils study without order. Those parts should be studied first which are most easily observed, such as the outer parts of the flower and the bark of a tree trunk, and those left to the last which are enclosed by other parts, and for the study of which other parts must be removed.

Third. In studying, work from the base upward, and from the outside inward.

To insist on a rigid compliance with these rules in every case would make our work mechanical. But it is helpful to keep them in mind, particularly in work with older children.

The order in studying structure, particularly with younger children, will be greatly influenced by the law of apperception, and the law of interest, so closely re-

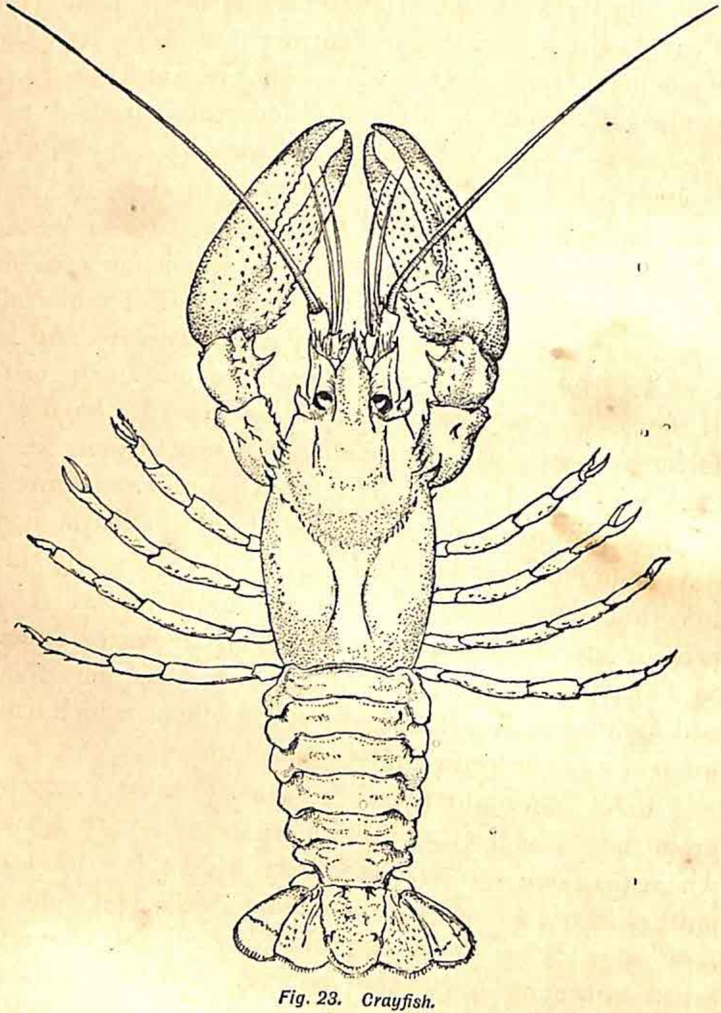


Fig. 23. Crayfish.

lated to it. The children will apperceive best and best build upon that in which they are interested. In studying the structure of the crayfish, for instance (see Fig. 23), if the children want to talk about its great "pinchers" first, let them do so, but not until they have studied the body and its divisions, and located the "pinchers" with reference to the body. From the "pinchers" they will naturally pass to the legs, and then to the swimmerets and tail fin, the parts by means of which the animal moves. Later can come eyes or feelers, large and small; the order is not material. The mouth parts, which are very difficult to see, and at best will not be understood, should be left to the last. If they begin the study of appendages with the large feelers or antennæ, take up next the small feelers most closely related to them. In studying the pea flower, if they are particularly interested in the little pod developing in the flower, it may be best to study this first, and consider the other parts in their relation to pod, to investigate the way in which they are formed so as to produce and protect the pod. We may then add another rule, subordinate to the others, which may influence the order in studying structure.

Fourth. Study first and emphasize those parts or properties in which the children are most interested, and which they can see best, and leave to the last what is most difficult to see or understand. We may find it best in studying limestone to begin with its effervescence with acid, or in studying mica to begin with its cleavage, or tendency to split into thin plates. These greatly interest the children.

What has been said about testing the order, clearness, and accuracy of a description by trying to draw from it, shows the value of drawing in the study of structure. The essentials in structure are the form and relative position of parts, and the best possible means of expressing these is drawing. As we have seen, we can at best get only an approximate and rather hazy picture of form from a word description. A few strokes with pencil or crayon will give us a better idea of crayfish or plant than we can possibly get from a word picture. When making a drawing of an object, we are compelled to observe much more carefully than when writing a description of it. We must notice the relative position and shape and size of every part we draw. On the other hand, nothing demonstrates so forcibly to ourselves, as well as to others, the lack of clearness in our ideas of form as the drawings we make. The youngest children see at a glance wherein the drawing they have made is incorrect or poor, when they do not and cannot see the deficiencies in a written description or word picture.

Remembering what was said in the previous chapter about the function and value of expression, we will find drawings most helpful in the study of structure in compelling pupils to observe carefully, and thus to gain clear ideas, and to express exactly, and thus convey those ideas to others, and in helping them to study and understand the drawings or pictures made by others.

It is an excellent plan, pursued in many schools, to place the object before the pupils without any previous study or description of structure, and tell them to draw it. These first drawings may be criticised and discussed individually or in class, and afterwards a second drawing made. After pupils have made a careful drawing, they are much better prepared to write a good description, if that is thought necessary. The drawing is frequently so much better than the word picture that it is not necessary or wise to ask for a written description. But it must be remembered that the most common, and usually the most convenient means of expression and communication is language; and children must learn to express by language as well as by drawings.

It is helpful to have each pupil make a drawing on the blackboard, and have the class select the best drawings, and tell why they are best. This makes them more careful and critical. The writer's experience has shown that even children in the first grade usually select the best drawings, and can tell why or wherein they are best.

We must remember that drawing from nature involves a more or less careful analysis of the thing drawn, a study of the relative position of its different parts. Pupils who have not been trained in this kind of drawing rarely have the power of careful analysis. If we simply place an object before the pupils, and tell them to draw, the results will be poor, particularly if the object is complex. The teacher must show her pupils how she draws it, lead them to analyze it with her, measuring (as when drawing the crayfish) the length of the body, and laying off this length, or some multiple of it, on the board, determining where the division line between the two main parts of the body comes, and measuring and representing the width at different points. Having represented the outline of the body, the details and appendages can be added. *The teacher's drawing must always be erased to prevent copying*, and the children asked to draw their crayfish in the same way.

At first pupils should draw only in outline, putting in very few details, as suggested in the drawing of the rabbit in Chapter II.

Whatever drawings the children make should be as careful and truthful as they are capable of making them. Otherwise the drawing may do more harm than good, tend to strengthen careless habits of observation and expression, and to fix in the child's mind incorrect forms.

It must be remembered that these drawings must express the ideas of the children, not those of the teacher, and must be examined and criticised from the standpoint of the pupil, not from that of the teacher. They must express the truth as the child sees it, and may be far from artistic. What is very poor from the standpoint of the artist or of the teacher may be very good when looked at through the child's eyes, regarded as the expression of his ideas.

The relation of drawing to nature study is farther considered in the chapter on expression (Chapter XI).

In describing structure, scientists use a host of scientific or technical terms. How far is it necessary or wise to use them in work with children? This can be largely determined by a consideration of the use or function of scientific terms, and of the characteristics of the child mind.

Scientific terms are not mere "hard words," as the non-scientific are prone to regard them. They express in the most concise, clear, and exact form ideas or facts. When the botanist describes the leaf shown in Fig. 24 as, "pinnately compound, with odd leaflet, with nine leaflets, opposite, short petioled, stipellate, ovate, slightly acuminate at apex, entire, pinnately veined," he expresses with a few words what cannot be as clearly or exactly expressed in non-scientific or ordinary language with five, or perhaps ten, times as many words. From such a scientific description, one familiar with the meaning of the terms used can make a fairly truthful drawing, and gain, of course, a fairly correct mental picture.

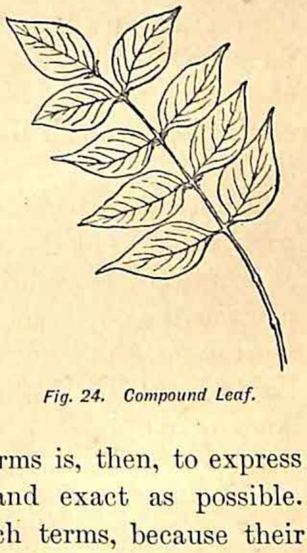


Fig. 24. Compound Leaf.

The main use of scientific terms is, then, to express facts in language as concise and exact as possible. Young children rarely need such terms, because their ideas are general rather than minutely exact. As children grow older their observations become, or should become, more careful and detailed, and they need exact terms to express them.

These should only be used so far as they are needed by the children to express their ideas. Children should never under any conditions be required to memorize a mere list of such words; the terms, for instance, used in describing leaves. If, on the other hand, they can be first led to see or realize how helpful these terms are, they will be glad to get them and use them. Children even in the first grade, studying the bean, who have been given no technical terms, and have been encouraged to describe in their own ways, after struggling for two or three days to tell about the "two halves," or the "two thick white parts," or the "two pieces which cover the little bud," will welcome the word "cotyledon" as a friend, and use it freely and correctly. No other word expresses the idea. In the morning-glory seed, where these cotyledons are so leaf-like, the children may call these parts seed-leaves, but not in the bean. After the children have gained an idea which they want to express in language, and have no word to express it, they need and will welcome the word, even though it is long. Until then they have no use for the technical term.

In general, the common terms, when they are exact in meaning, are much better for young children than the technical terms, — feelers better than antennæ, breathing-pores better than spiracles.

On the principle of apperception, scientific terms will mean more and be more readily remembered just in proportion as they are closely related to what is already in the child's mind. This can be done by always explaining their meaning. When the child knows that plumule means "little feather," and lanceolate means "lance-shaped," and micropyle (the opening in the skin of the seed through which the growing end of the embryo pushes) means "little gate," and calyx means "cup," and pinnately means "like a feather," they will remember the terms more readily, and use them more intelligently. If the oldest children know the meaning of a few root words, they can often form many words by combining these; such words, for instance, as *epi*, upon, and *peri*, around, and *hypo*, under, used in forming the botanical terms, epi-sepalous, epi-petalous, epigynous, perigynous, etc.

In the case of words describing forms, such as those relating to leaves, it will be found helpful to have charts prepared and hung up in the schoolroom showing the forms and the words together. These will keep the forms and the words expressing them constantly associated before the pupils' eyes. The pupils can refer to these charts to find the proper terms to express exactly the forms of the leaves or other objects they are studying.

As has been said before, the story of life history, of development from germ to adult, may be brought out in connection with life and function, or after the study of structure. When the children can watch development, as of the tadpole into the frog, and of the caterpillar into the butterfly, this becomes a study of successive adaptations, or adaptations to different environments, and may well be studied in connection with habits as a preparation for structure. Where the story of life history is simply told to the children, it is best, in general, to leave it to the last, that is, until after structure, because some knowledge of structure will be necessary to understand life history, as in grasshopper or crayfish, and because the life history, being merely told to the children, will be hazy. What is hazy, the weak link in the chain, should be left to the last and made subordinate, so that later important steps will not depend on it.

We have studied plant or animal or stone as to: —

First. Its name and significance of name.

Second. Its relation to natural environment.

Third. Its habits and the functions of its parts (and its life history?).

Fourth. Its adaptation to function or its structure (and life history?).

In the endeavor to farther unify our knowledge, the object or phenomenon studied must now be compared with others like and unlike it, so that what is like it may be grouped with it, and what is unlike separated from it. Thus in time the things we have studied are not mere individuals, but types of classes, — the grasshopper of hundreds of insects, the robin of scores of birds, the buttercup or wild rose or lily-of-the-valley of groups or families of plants; and the experiments we perform explain many phenomena, — as the evaporation and condensation of water from the tea-kettle help the pupils to understand about the formation of dew and rain and mist and fog and cloud.

The purposes or objects of comparison or association, and of classification or generalization, are: —

First. To train the child to note and study carefully resemblances and differences in objects before him. The young child usually sees differences most readily. For classification the teacher must emphasize resemblances and help him to see them.

Second. To lead him to distinguish the essential or important from the non-essential or unimportant in the form of plant or animal, or in the property of mineral, or in physical or chemical phenomena, and to relate or group or classify in accordance with essential resemblances and differences.

Third. To help him to recognize or abstract the general plan in plants and animals, and general principles or laws in physical phenomena, and to realize more and more a unity in apparent diversity.

Fourth. To lead him to apply his generalizations to other phenomena, and to arrange his knowledge in the most convenient form for ready reference; to "tie it up in assorted bundles ready for use," each bundle or group or class labelled and represented in the mind by a type. Thus the bee may represent the insects, or the membrane-winged insects; the robin or sparrow the birds, or the perchers; the cat the vertebrates, or the mammals or the flesh-eating (carnivorous) animals or the cat family, depending on the extent to which the knowledge has been assorted and grouped.

Lessons VII and VIII in the outline for the study of the rabbit, given in Chapter II, illustrate order and method in comparison and classification, and bring out the application of what is here presented.

The work in association and comparison can and should be carried on from the very first with the little ones in the first grade. Gradually, certainly in the second year, they can begin to discriminate more carefully, pick out essentials, and see something of plan. Later, in the third or fourth grade, and in subsequent years, more emphasis should be placed on recognition of plan, and of principles or laws, and on definite classification.

Success in comparison and classification — that is, real classification by the pupils, not a mere memorizing of classification given by teacher or book — depends almost entirely on the character of the previous study of structure. If the teacher has required definite and exact observation, and if she has kept in view the classification to come later, and has emphasized those points of structure which she (but not the pupil) knows to be important in classification, there will be comparatively little difficulty when pupils are old enough for generalization. In comparing the crayfish and crab (see Figs. 23 and 25), to get the general notion of the class of animals (crustacea) to which both belong, the children will recognize the resemblance, if in the study of the crayfish the teacher has dwelt on plan, on the divisions and covering of the body and the number, position, and character of legs and other appendages. If she has been satisfied with a glance at form and color and length of parts, and paid little attention to plan, she will find that the children cannot classify for themselves. They have no foundation for it. If in the study of the rabbit the teacher has made sure that the pupils have observed carefully the peculiarities in the rabbit's way of eating and in his teeth, there will be little difficulty in having them see for themselves how the rabbit and squirrel are related, as "gnawers" or rodents.

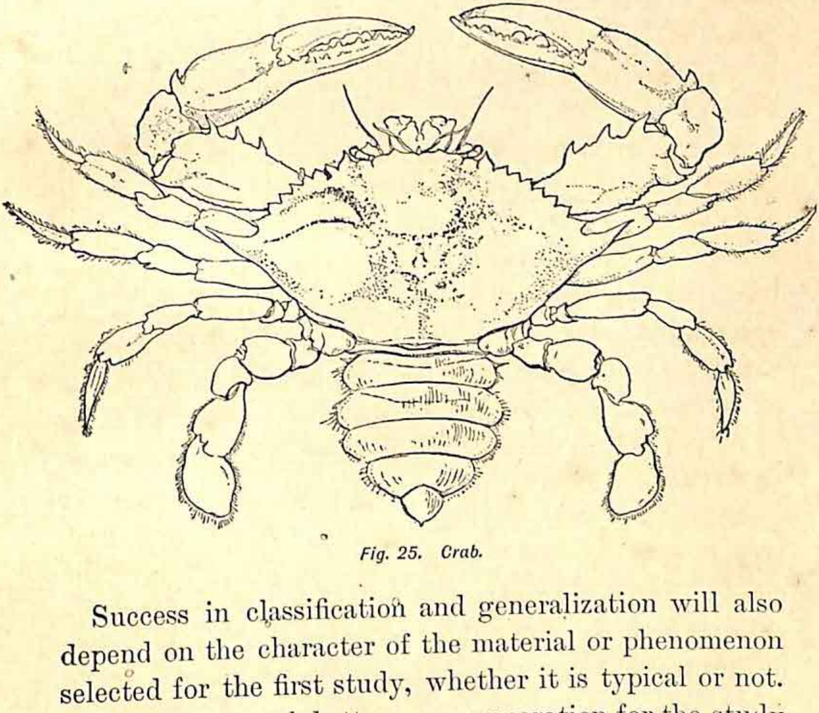


Fig. 25. Crab.

Success in classification and generalization will also depend on the character of the material or phenomenon selected for the first study, whether it is typical or not. The rabbit is much better, as a preparation for the study of rodents, than is the mouse. This is discussed in Chapter XIV on the selection of material.

Remembering that in classification or generalization we wish the child to see and to fix in his mind resemblances, rather than differences, and to recognize similarity of plan or cause or law, we must endeavor to first associate or bring together and compare those objects which resemble one another, and then those which differ more. The results will be much better if we compare the crayfish with the lobster (see Fig. 26), and then with the crab to get the idea of crustacea, than if we first compare crayfish and crab, which are so different from each other.

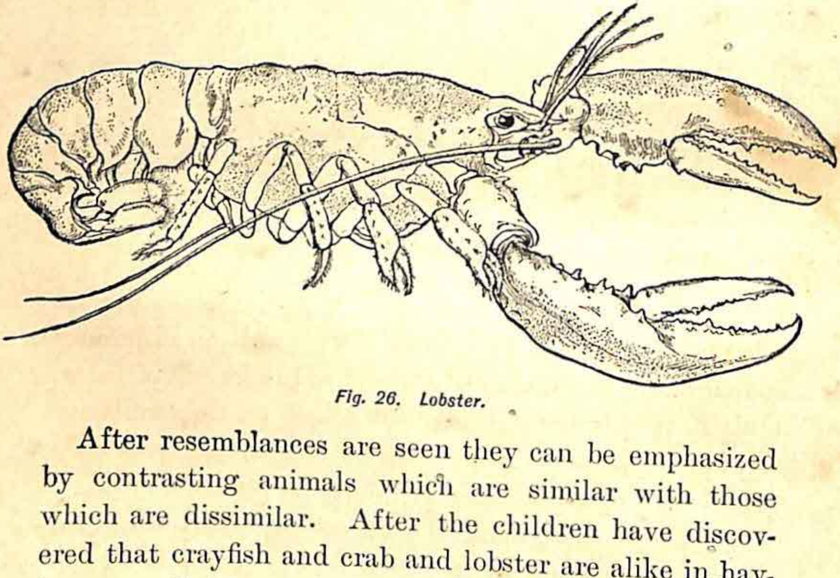


Fig. 26. Lobster.

After resemblances are seen they can be emphasized by contrasting animals which are similar with those which are dissimilar. After the children have discovered that crayfish and crab and lobster are alike in having two divisions of the body and five pairs of legs, they can be compared with the grasshopper (Fig. 27), which has three divisions of its body and three pairs of legs. This will bring into sharper relief, and prepare for the study of, the distinctive characteristics of crustacea.

We will succeed in bringing into prominence in the pupil's mind the essentials in structure, or plan, or physical phenomena, and thus leading to classification or generalization, in proportion as we lead the pupils by our questions, to see and dwell on these essential features. If we encourage or allow a careful comparison of the multitude of details, often more or less accidental, such as color and minor markings, and length of parts, the association and comparison may have little result. In the comparison of dandelion and thistle (see Chapter I), we will gain little if we dwell on difference in color, and in number of florets, and in length of parts. Only in proportion as the pupils dwell on the similarity of plan in the dandelion and thistle blossoms will they get an idea of the composite family of plants.

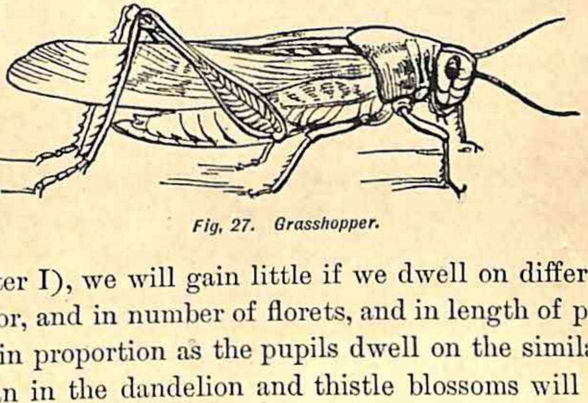


Fig. 27. Grasshopper.

It will be seen that the process of abstraction and generalization requires the most careful work in development or questioning. In the previous steps the children, if properly taught, will accomplish much with very few questions. In generalization, particularly when made from few particulars, the pupils must be led by the teacher.

One precaution is very necessary in the process of generalization. We must constantly resist the tendency to generalize from too few particulars. Broad generalizations based on very few particulars lead to careless, hasty, and often erroneous thinking. While schoolroom conditions will not admit of the study of the great number of particulars which must precede thoroughly scientific generalizations, we must be exceedingly careful about generalizing from one or two particulars. We must multiply experiments before deducing laws, and study as many plants or animals or minerals as the condition and interests of the children make possible before passing to classification.

We must not be satisfied when the children have worked out the generalization. These generalizations must be frequently applied to other plants and to other physical phenomena, so that the habit of working up to and making use of generalizations may be fixed.

This brings us to the last step in the method of presenting or studying material. We must apply what has been perceived and apperceived, and related and unified, to other phenomena. Thereby we cannot only fix and clinch in our mind what has been learned, but we can make it a means of further development and better adaptation, or broader unity.

When the children have learned about the conduction of heat, they should apply the knowledge to the explanation of a host of familiar facts, by studying such topics as clothing, storm-windows, stove-lifters. When they have discovered the distinctive characteristics of the composite family of plants, they should be led to gather and relate all the kinds of composites they can find. When they have learned how plants in the schoolroom develop, they should apply what has been gained in the investigation of the germination and development of several plants out-of-doors.

Here we can and should strongly emphasize (particularly with older pupils) practical applications. The study of the dandelion seeds, with their hairy sails, may thus lead to the hairy cotton-seeds and the cultivation and process of manufacture and great value of cotton. From the flax we may pass to linen, and from the sheep to wool and to its manufacture and uses.

In connection with this step will come many opportunities for supplementary reading. In thus broadening the pupils' ideas, making what they have seen helpful in understanding what they cannot see, but must read about, such books as "Stories of Industry" and King's Geographical Readers are very valuable. (See also Chapter XII.)

What has been learned in the nature work should also be applied in other school-work. Nature study thus becomes the basis for physical geography, is very helpful in commercial geography, and throws much light on political geography. It may illumine much that the children read. It becomes a foundation for the expressive work of the school.

Teachers and pupils are prone to think that when a subject or topic has been completed, nothing more is to be done with it. Each thing completed, be it one fact or a broad generalization based on many facts, is but a means of apperceiving new ideas, a link in another sequence, a help in higher generalizations, a preparation for greater unity.

The applications of nature study in other schoolwork, and the methods of relating nature studies to other studies in the elementary schools, are considered in Chapters XI, XII, and XIII.

The question naturally arises, Is it always wise to follow from beginning to end this order of study, to consider each of these steps in studying any object? No, most decidedly. While this indicates the line of thought, the point at which we begin or end and the relative emphasis placed on different steps must be determined by the age of the children, the character and amount of preparatory work, the material available, and other conditions.

With young children we will place all emphasis on relation to environment, life, habits, and function, with very little comparison and application. Children are not ready for much work in the later steps. As the children become older, they are prepared for a more thorough study of structure, more work in classification, and can make a wider application of what they have learned. The older the children the more important in general are the later steps, which involve wider knowledge and require power of generalizing.

Where children have had nature work in the lower grades, much, but not all, of the earlier work can be done there, and in the upper grades the work can be built upon these foundations.

Where living animals or growing plants can be easily procured, the study of relation to environment and habits can and should be strongly emphasized even with older pupils. When only mounted specimens or pictures can be obtained, then comparatively little attention can be given to habits.

Closely related is the question as to the time to be devoted to the different steps, or to the whole work in the study of any topic. This must also be determined by the age of the children and by conditions. Children in primary grades may devote from one to four or five lessons to a plant or animal. It takes a very strong teacher to keep little folks interested in one thing longer than that. In the upper grades ten or fifteen or more lessons may be profitably devoted to the intensive study of such topics as corn, the rabbit and the family of "gnawers," the cat and the cat family, the pine and its relatives and their economic uses, coal, iron, etc.

The order of study as outlined is very generally applicable in the study of living or organic nature, plants and animals. Much the same line of thought can and should be followed in the study with children of inorganic nature, of minerals and rocks, and of physics and chemistry.

In studying such a rock as limestone, the first step after the children know what they are studying, and have noted the distinctive properties by which they can recognize it, is to relate it to its natural environment, to describe the places where and the conditions in which it is found, and, if possible, show how it is affected by its environment; how it crumbles or disintegrates and forms soil under the action of rain, air, roots; how it is worn away and carried along and deposited by waves and streams. If it is possible to study this reaction between the stone and its environment, which corresponds to habit in living nature, it will make much more intelligible the next step, the life history or story of the formation of the limestone. When the children see that the solid rock breaks down into mud, they will be better prepared to understand that it was formed from mud and animal remains. The story of the animals and other agencies which formed it, and of the process of formation, is largely recorded in its structure, and thus leads to and prepares for the study of the structure of limestone, its fossils and layers, and perhaps of its uses and adaptation to uses. From this we can pass to comparison with other limestone, perhaps with other lime rocks previously studied. The last step is the application, such as the relation of what has been studied to geography, the uses of limestone, and of materials made from it, and the processes of manufacturing lime.

A similar line of thought can be followed in the study of sandstone and shale and granite, and of such minerals as coal, the iron ores, quartz, graphite, and pyrite.

In studying physics and chemistry this order is not so applicable, and yet a similar line of thought can be advantageously followed, particularly with younger children. In the study of heat we can begin with its sources (leading and relating finally to the ultimate source, the sun), investigate next its work or function or effects (from which alone scientists, but not children, may gain some idea of what heat is, what may perhaps be termed its structure), and gradually, after many comparisons, generalize or determine laws or principles, and, lastly, apply these principles to the explanation of other phenomena. The line of thought is much like that followed in studying plants and animals. In work with gravitation, the pressure of liquids or of air, magnetism, and other physical forces or phenomena, a similar line of thought can be followed.

CHAPTER XI.

NATURE STUDY AND THE EXPRESSIVE WORK OF THE SCHOOL.

We have formulated the aims and discussed the psychological principles which must determine method in nature study, and have considered the application of these principles in the study of material.

We must now turn our thoughts to the relation of nature study to other school-work, and to the means and methods by which it can be made most helpful in such work.

In planning any work for elementary schools, the advocate of nature study must keep in mind the immediate object of these schools. That object, as recognized by most school officers and parents, is to teach reading, writing, arithmetic, geography, — "the essentials." Many teachers look little farther.

The educator who has deeper insight and a broader and higher outlook looks beyond these immediate objects to higher aims, — the development of the whole child, the building of character, the perfecting of the relations between the child and his environment, nature, man, and God.

The two objects are in no sense incompatible.

Rightly considered, one is simply one means by which the other may be attained. The parent or teacher or school officer is perfectly right in believing that the children must be taught reading, writing, arithmetic, and geography, and right in opposing the introduction into our schools of anything which takes the place of these "essentials," or weakens the effective work in them.

While nature study has a most important place in our elementary schools, just as science has a place in higher educational institutions, independent of its relations to or effect on other school-work, the extent to which it makes and keeps a place in the average school, under average conditions as they exist at present, with average school officers and teachers, will depend very largely on the extent to which it is shown to be helpful in other school-work. The opposition to nature study by the stanch believers in "the three R's" will be best overcome by those who most conclusively demonstrate that nature study does not in any way take the place of the essentials, but, rightly taught, greatly helps them.

Nature study is simply a recognition of the dependence of the child on sense-perception. What comes through his senses makes the clearest and deepest impression, and forms the best foundation for expression in language, drawing, and reading, for geography and for other school-work.

The relation of the work of the elementary school to the two immediate centres of education, nature study